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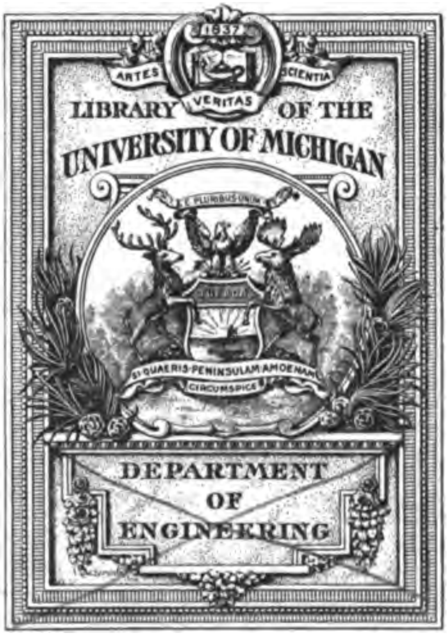

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1916

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The following has been suggested:

"National Guard Coast Artillery: Armory Instruction, and Preparation for Service Target Practice and Service Conditions."

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IZATION AND TACTICS OF COAST ARTILLERY GUN DEFENSE

APTAIN JAMES A. THOMAS, Coast Artillery Corps

Introduction

tics is the art of disposing and maneuvering troops on
d of battle.—Wagner. This definition, although true,
mplete. Fire discipline, fire control, and fire direction
y an important place in General Wagner's work on "Or-
ation and Tactics" for mobile troops and are extensively
ed by him in that work. If these subjects find so necessary
ace in the tactics of infantry, cavalry, and field artillery,
w much more important and vital a place they must neces-
rily hold in the tactics of coast artillery can be readily under-
ood and appreciated, when it is realized that the potency of
is branch of the service depends almost wholly upon fire
ction.

Battle tactics of coast artillery treats of the fire action of the three classes of armament—Primary, Intermediate, and Secondary—during an engagement, and includes a knowledge of these different types of weapons, their uses, limitations, and powers; the purposes and characteristics of the different classes; the part they are created to perform in the coast fortifications and how best to do it.

It is not sufficient for a commander to have a knowledge of the uses, powers, and limitations solely of the unit under his control and how best to employ them; it is of equal importance that he be thoroughly familiar with those of all classes of

nse units, while for tactical purposes we have the Battery, Fire (Mine), the Fortress, and the Coast Defense units.

At one time the necessity for a unit in the tactical chain artillery command between the Defense Command—or as it s then known, the District Command—and the Fire (Mine) mmand was recognized and provided for. This unit was signated Battle Command, and its functions were to secure combination and co-operation of that armament which had common or contiguous field of fire.

This unit has been displaced by the present unit, Fort Command, and the fort commander has tactical control over all matériel and personnel within the limits of his fort. In exercising his functions as a tactical commander he has control and authority over batteries or other units which may properly be, and often are, units of a fire command whose commander is located at another fort; hence a dual control and authority exists. Should this fire commander not be fort commander at the fort where he is located, he would in fact have no command whatever, as the units of his command would be under the divided control of the fort commanders. Again should the two fort commanders decide to exercise control over the batteries, situated respectively on their forts, the fire command as a unit would cease to exist and pass away altogether. Further, should the armament at a given post consist of a mine casemate, a rapid fire battery, a primary gun battery, and a mortar battery, a condition very common in our defenses, these units cannot properly be combined into one fire command. On the contrary, separate fire commands must be formed for each, unless they be grouped with other batteries located on a separate fort or forts, which is always done when possible for the sake of efficiency, and properly so too. From this it can readily be understood that should the fort commander exercise tactical control he must assume the duties of a *fire* or *defense* commander, unless a unit between them is provided.

That such a unit is necessary needs no argument or proof. That the unit, fort command, does not supply it is equally evident. The fort commander's authority is restricted to the limits of his own fort, and to delegate authority to the senior fort commander of the various forts to exercise the desired control causes his designation and that of his unit to be a misnomer.

For the above reason a new unit, or in reality the revival of an old one, is suggested and is designated the Fortress Commander. Such a commander should exercise tactical functions only, and exactly those which were originally prescribed for the Battle Command. Such a unit will be used throughout this article.

It might appear from casual observation that the double unit system—company, fort (post), coast defense, for administrative; and battery, fire, and fortress for tactical purposes—would be conflicting and operate against efficiency; the contrary is true, however, and the double system of units is most desirable.

The number of troops furnished for the defenses already constructed constitutes but a small percentage of those that would be required to operate and serve them in time of action. Those now provided are scattered throughout the defenses for the purpose of preservation, thus it is not always possible to have a complete tactical unit larger than a battery.

It is, therefore, preferable for the purpose of preservation and maintenance, to have at least one battery unit (gun or mortar) and one mine unit at each fort; and each unit a separate company for administrative purposes.

A company operating a gun or mortar battery, and formed as a battery command unit for the purpose of drill, instruction, and service is a satisfactory and complete tactical unit for artillery purposes; and as such operates as a unit of the next higher unit, the fire (or mine) command, of which it is an integral part without reference to any other unit of the command. It is not dependent on the presence of other units for drill, instruction, or service of the battery; it can and does operate alone. In this respect it is unique, differing as it does from a company in the battalion unit of a mobile force whose efficiency in drill, instruction, and service does depend upon the presence of the other units to maneuver in conjunction with it.

Furthermore, coast artillery troops are armed, equipped, and drilled as infantry, formed into provisional regiments, and annually undergo infantry field training. The administrative units of the company, fort (post), and defense commands correspond to, and are readily converted into, the tactical and administrative units of the company, battalion, and regiment of infantry organization.

THE BATTERY

The basic tactical unit of coast artillery must conform to the same standard requirements as those of any other force, and also to additional ones imposed by certain physical conditions of the armament with which it is associated.

The fundamental requisite of any tactical unit is that it must consist of the largest number of men which can be personally controlled when in action by a single individual.

In the infantry the battalion of 579 officers and enlisted men is the tactical unit, in the cavalry the squadron of 416, and in field artillery the battalion of 550. These units, while of different strength, fulfill the requirements of a tactical unit for their respective services. The variation in strength is due to the different weapons with which they are armed and the different purposes for which they are created.

The tactical unit of coast artillery will vary in strength for a like reason, and also because of the multiplicity of calibers of the armament, the varying number of guns in the separate batteries, and the different types of carriages on which they are mounted. The battery unit must, therefore, vary in numbers to meet each of the above conditions, and becomes a tactical unit of indefinite strength.

The battery, as a unit, is composed of a range section to determine the corrected range and transmit it to the guns; a gun section and an ammunition section to operate each gun of the battery. Such a unit comprises the largest number of men which can be directly commanded by a single individual. This qualifies the battery as the basic tactical unit for coast artillery. Furthermore, such a unit contains within itself all the elements, and no others, necessary to independently enter and sustain an engagement.

THE FIRE COMMAND

Batteries which have a common or contiguous field of fire are grouped together for the purpose of effectively controlling the rate, dispersion, and concentration of their fire, and the amount of ammunition used. Such a group of batteries constitutes a fire command.

Batteries of the same general class and power are designed for the same tactical purposes; they have practically the same rate of fire, use the same character of projectiles, employ the same method of fire direction, and are properly placed in the same fire command.

Experience has demonstrated that a single commander cannot to the best advantage observe and direct more than four batteries, and this number is accepted as a maximum for a separate fire command.

The naval division consists of four vessels of the same type and class and is the naval tactical unit for maneuvering a squadron or fleet. Thus a fire command of four batteries becomes a most desirable and convenient unit for the purpose of attacking such a target. A fire commander can designate a separate vessel for each battery or concentrate all batteries on a single vessel.

A fire command should not include a battery which has an important part of its field of fire obscured from the fire commander's station. Where a condition of this kind exists it is better to form a separate and independent command.

The fire command of four batteries fulfilling all the foregoing conditions would seem to be the logical and most efficient basic unit. It would be used as such but the fire commander's station is always at some distance from the nearest, and often a considerable distance from the farthest battery, and control is exercised by means of telephonic communication, often very poor and likely to become interrupted or destroyed. Besides it is not near enough to any battery for the fire commander to give it his personal and individual attention and he could not personally command all of them. Under these circumstances it is best to designate the battery as the ultimate basic tactical unit which it most probably would become of necessity, under the strain and turmoil of a severe or protracted engagement.

Mortars possess many tactical advantages over guns and have a more diversified sphere of action, hence they always form separate fire commands.

Mine fields are so located that the water area in which they are placed is in unobstructed view from the mine commander's station. Rapid fire batteries, whose fields of fire cover this water area and which are assigned for the defense of the mine fields, together with the mine fields, form the mine command.

THE FORTRESS COMMAND

To secure a combination and co-operation of the different fire commands and to harmonize their action, it is necessary to group them together. When so combined, they form a fortress command.

The battle area of a coast defense consists of the area covered by the fire of the armament, and which must be occupied by a hostile force in order to deliver an attack upon the defenses. When such an area can be viewed and surveyed throughout its extent from one observing station, all the armament whose fire covers it, or an important part of it, should constitute a single fortress command. When this condition does not exist, separate fortress commands are formed for each field of view of those fire (mine) commands whose armament does cover it.

Fire (mine) commands are grouped to form fortress commands without regard to class or caliber of their armament. A grouping to secure uniformity in this respect finds no place or purpose in the tactical employment of coast artillery.

The functions of a fortress commander are to estimate the situation, decide upon and put into action a plan of operations to defeat the enemy. He carefully studies the formation of the enemy's fleet prior to and at the commencement of the attack, forms an opinion as to what the enemy contemplates attempting, decides the plans of action necessary to defeat him, and issues orders to carry his plans into effect. Throughout the engagement he issues such additional orders to the fire commanders as are necessary to secure combination and co-operation of all elements of the defenses. He directs when to begin and when to end the engagement.

Throughout the engagement he carefully observes the fire effect, changing fire commands from one target to another, concentrates their fire on a particular vessel or division, and, in general, designates targets for the separate fire commands, or orders independent action as he deems proper or expedient.

It should be understood that the area of a fortress command is extensive, limited only by its commander's field of view and the range of the armament of his command; that patrols, detachments, divisions, or squadrons of a hostile fleet will probably approach the defenses from many different directions, and while he is expected to see all vessels which enter his battle area, it must be appreciated that some may enter unobserved by him. It is, therefore, the duty of all fire commanders to bring to his attention all vessels of the enemy which are not engaged or those that they have the slightest reason to believe have missed his observation. In cases where the fire commander believes the fortress commander has failed to observe a vessel, and such vessel offers an exceptionally favorable target for attack by his command and immediate action is necessary to take advantage of it, it is his duty to exercise his own judgment and act accordingly, reporting his action to the fortress commander as soon as practicable.

THE COAST DEFENSE

Coast defense commands are established, their limits fixed, and their administrative headquarters designated in orders from the War Department. (Par. 299, D. R. C. A. C., 1914.)

The coast defense commander is both a tactical and administrative officer. His administrative duties are clearly defined in army regulations.

As a tactical commander, he exercises authority over all elements of the defenses, over all troops within the limits of the defense area, over all naval forces within the area and designated for defensive purposes. He is charged with the duty of organizing and co-ordinating the forces of his command, and securing co-operation of the different parts. He plans all military operations necessary for a proper and successful defense and directs their execution.

In repelling land or aerial attack, his duties are those of a commander of a mobile force acting on the defensive. In repelling naval attacks, he may assume and exercise the duties of a fortress commander, or give such general instructions to them as he deems proper and expedient.

There is no separate place or necessity for a coast defense commander in the tactical chain of artillery command, other than that of a general and supervisory nature.

CHARACTERISTICS OF COAST ARTILLERY

Coast artillery is preeminently the defensive branch of the military establishment of a country. It is created and designed to protect the seaboard against hostile attacks. It has no other mission.

Coast artillery mans and operates the permanent fortifications erected to prevent given and well defined water areas from being occupied by a hostile navy; either permanently as a base of operations, or temporarily to pass from one field of action to another.

Coast artillery is by many millions of dollars the most expensive branch of the military establishment to arm, equip, and operate.

In the permanent coast defenses are mounted in fixed positions the weapons of coast artillery, weighing many hundreds of tons and protected by large masses of earth, concrete, and steel. Vast magazines are required for the storage of ammunition and mechanical means are necessary to deliver it to the guns. Large electrical plants are required to furnish power and light. Extensive telephonic communications for directing operations, and long base lines by which to compute the great ranges at which it fires, are considered necessary. Conditions and requirements such as these preclude any idea of mobility and impose limitations which are considered indispensable to a mobile force.

Coast artillery cannot initiate an action but must wait for the enemy to attack; it can refuse to engage in action but cannot ward off blows nor seek safety in a retreat or flight: it must fight to the end, or surrender. Coast artillery cannot change its formation nor maneuver for an advantageous position; hence it must fight an enemy in whatever formation he may assume, at such ranges as he elects, and in any position he takes. If the enemy is defeated or seriously injured and can creep, or be towed beyond the zone of artillery fire, he cannot be followed up and destroyed. He is free to repair his injury and return again to the fight. If he cannot escape, he must be destroyed as there are no means by which a surrender can be received or accepted. Accordingly, the spoils of victory are denied coast artillery.

Many important advantages accrue to coast artillery though because of its immobility and which more than compensate for those lost because of a lack of it. The weight and power of guns which can be mounted and operated are limited only by the strength of the material used in their construction. Any design of carriage or mount can be employed, permitting the use of any desired angle of elevation for firing. The number of locations for battery sites is practically unlimited and the number of batteries which can be erected is limited only by financial resources. Any degree of protection can be obtained by increasing the amount of earth, steel, and concrete in the batteries, and extensive magazines can be erected for the storage of ammunition and supplies. By employing fixed mounts, a stable platform is obtained from which to fire; consequently, a decided advantage in greater accuracy of fire over the rolling platform of a ship's deck, and the derangement due to recoil in mounts of a mobile type is obtained. By employing indirect laying, inaccuracy of aiming due to nervousness or excitement on the part of the personnel is eliminated. By employing long horizontal base lines, an accuracy in the calculations of extreme ranges is obtained which cannot be secured by any system of spotting or by the use of any vertical or self-contained range-finding instrument known. By the use of guns of unlimited weight and power, and carriages which permit of the use of any angle of elevation when firing, and long horizontal base lines for determining extreme ranges, coast artillery enjoys a distinct and invaluable advantage over any armament which can be brought against it.

Classification of Armament

There are various ways to classify armament, but for tactical purposes it seems best to classify it as to power and purpose for which designed.

PRIMARY ARMAMENT

This is of the first order. It includes guns of the greatest caliber and length, capable of throwing projectiles of the heaviest weight and largest size with the greatest velocity, designed to perforate the thickest armor carried by warships at mid-range, and to deliver the greatest amount of explosive charges at distances where perforation cannot be attained.

Guns of the primary armament use direct and indirect methods of aiming: Direct aiming when the target is visible from the gun; and indirect aiming or laying when the target is invisible from the gun and when the range and direction of the target from the gun can be furnished, or the fall of the projectile can be observed from some observation point and the fall of the shot reported to the guns.

There are two kinds of projectiles furnished for use with this class of armament: Shot for use at those ranges where perforation is certain, and shell for use at other ranges or occasions when a great explosive or shattering effect is desired. Both types of projectiles carry a bursting charge but differ in wall thickness and amount of explosive carried. Two kinds of fuses are furnished, non-delayed action for shell and delayed action for deck-piercing shell and shot. The rate of fire is about two shots per minute.

Mortars belong to this class of armament but have very little in common with the guns and possess many advantages over them. Considering four mortars as a unit, they excel guns in accuracy of fire. They employ indirect aiming and iver their projectiles upon the deck of a vessel where the nor protection is weakest. They possess the greatest protion from all naval attacks, which secures to the mortar tions an unusual amount of freedom from the excitement d stress of battle and permits them to perform their duties ith methodical accuracy.

Mortars use two types of projectiles and fuses similar in sign to, and used for the same purposes as, those furnished uns. Shrapnel might well be furnished as its usefulness to ttack small vessels, landing parties, and troops ashore can readily be appreciated.

Mortars are the complement of guns in attacks on naval vessels of the first class. At those ranges beyond which perforation of the side armor cannot be obtained by guns, mortars, because of their high trajectory, obtain sufficient energy to perforate the decks. At those ranges where guns can perforate the side armor, mortars deliver on the decks explosive shells carrying a maximum amount of explosive.

Mortars have an all-round fire and a range as great as that of any gun, making them a most useful weapon in the defense against attack from the land side.

Where mine fields and submarine obstructions are placed in water of not more than about fifty feet deep, mortars furnish a unique defense for them against attack by submarines. With their salvos of eight or sixteen shells, fitted with delayed action fuses, dropped in the vicinity of a submerged submarine whose location is known or suspected, the explosive effect under water if near enough will crush in the sides of a submarine or otherwise injure it. The effect of such an explosive, if not close enough to damage, will certainly be felt within a wide radius and produce a great moral effect.

INTERMEDIATE ARMAMENT

This comprises guns of medium caliber but of high power, in which the rapidity of fire and a flat trajectory are of a prime importance. They are designed to attack unarmored or lightly armored vessels, especially those of high speed. This class of armament finds great usefulness in protecting mine fields, landing places, and in supplementing the primary armament under favorable range conditions. It is equipped for both methods of firing, but uses direct aiming almost exclusively. It is furnished three kinds of projectiles and fuses—shot equipped with the delayed action, and shell equipped with non-delayed action fuses for use against material objects, and shrapnel equipped with time-percussion fuses for use against animate objects.

SECONDARY ARMAMENT

This comprises all guns not included in the two foregoing classes and is generally of 4-inch caliber and less. It is designed to obtain the greatest rapidity of fire possible, to furnish an effective defense for mine fields against attacks by small naval vessels and submarines, to protect landing places and supplement the intermediate and primary armaments under favorable conditions of range by attacking the superstructure and unarmored portions of warships.

Guns of the secondary armament use fixed ammunition and are furnished projectiles and fuses of the same types and for similar uses as those of the intermediate armament.

General Naval Conditions

Operations other than raids, undertaken against the coast defenses of a country presuppose a naval superiority or command of the sea by the attacker, and when projected the commander of the attacking force is given definite and explicit instructions as to his mission, the kind of operations he is to institute, and what his limitations are, if any.

Naval operations are always undertaken for some well defined purpose and may include one or more of the following:

a. Blockade.
b. Reconnaissance.
c. Demonstration.
d. Raid.
e. Bombardment.
f. Run-by.

BLOCKADE

In a military sense a blockade is the stopping or interrupting of communication by sea with all or a part of the coast-line of a country and corresponds to an investment on land.

There are as many kinds and classes of blockades as there are purposes for which they are established; all, however, are susceptible of classification under one of the two following general heads: Commercial and war blockades.

Commercial Blockade

A commercial blockade is one in which the commercial intercourse only of a country is interrupted or prohibited. It is usually undertaken or imposed by a strong nation, or a combination of nations against a weaker one for the purpose of exercising duress. It does not of necessity constitute a cause of war. Such a blockade was established by the navies of England, Germany, and Italy in 1902 against Venezuela. In the present European war the Entente powers have established a commercial blockade against Holland, Denmark, Norway, and Sweden, to prevent commerce passing into Germany. The detention of Greek vessels by these same powers in their own ports is also a phase of this class of blockade.

War Blockade

This form of blockade is one established as a naval operation to close the ports, waterways, or coast-line of a country to all intercourse, to shut up and render impotent the naval forces of a country, or to operate in conjunction with an army against coast fortifications.

The navies of the Entente powers have established and maintained all classes of war blockades during the present war. The coasts and seaports of Turkey are blockaded by the navy of Russia on the Black Sea and by the navies of France and England on the Mediterranean Sea. The navies of England, France, and Russia have effectively bottled up the German navy in its ports on both the North and Baltic Seas. The blockade of the Dardanelles by the French and English navies is an example of the last class of blockade; in this case the navies blockaded and, at the same time, took an active and important part in the attempt to reduce the fortifications.

War blockades are sometimes sub-divided into outward and inward blockades. The distinction being, in one case that the expected attempt to run or break through the blockade will be made from the sea side, and in the other from the land side. An example of the outward blockade is the one now maintained by England against commercial intercourse by neutral countries with Austria and Germany and made effective by the cordon of war vessels stretching from the North of England to the Arctic Circle. The blockade of Santiago in 1898 by the American navy was an inward blockade.

Blockades are further designated as paper blockades, pacific blockades, etc., but such distinction is of a political rather than military value.

The blockade of a coast fortification of itself becomes effective only when the defenses can be deprived of all sources of supply, and a surrender forced through starvation or the exhaustion of military stores. Such a blockade can occur only when the blockading fleet can control all surrounding water area, or when an investment from the land side is made complete by an army.

Vessels blockading a coast fortification usually take station beyond the range of the armament of the fortifications. During thick weather and at night they may close in to obtain a better view of the harbor entrance, especially if war vessels are within the harbor.

Any attacks or engagements undertaken by the blockading fleet may, but will not of necessity, be connected with the maintenance of an effective blockade.

RECONNAISSANCE

When operations are projected, the naval commander is supplied with all information of a military character or nature concerning the defenses against which he is to operate. This information has been collected in time of peace by an intelligence department from many sources and by various means, such as consular officers, secret agents, spies, newspapers, officials, publications, navigation charts, maps, etc. It is surprisingly accurate and full, and concerns itself with the strength, character, and location of the fortifications; character, numbers, and resources of the garrison; resources and topography of the surrounding country; also the disposition, strength, and class of vessels comprising the hostile naval forces.

It would be erroneous, though, to suppose that this information is detailed or complete; it is not and must be verified, corrected, and brought up to date. This is essential and requisite before an intelligent plan of campaign can be formed and offensive operations launched. Eliminating aerial reconnaissance, the only way by which such a knowledge can be obtained is by naval reconnaissance.

A naval reconnaissance of a coast defense may be defined as an operation undertaken by naval vessels for the purpose of eliciting information concerning the fortifications. The information desired is usually:

a. To locate the position of the batteries, determine their arcs of fire, dead areas, caliber, extreme range, and appearance.

b. To test the strength of the armament.

c. To locate observing stations, searchlights, signal stations, etc.

d. To locate mine fields and obstructions, their boundaries and cable landings.

e. To locate and survey places suitable for landing troops and raiding detachments.

f. To explore the inner harbor for presence of naval vessels.

g. To verify and correct information already obtained.

h. To locate and chart conspicuous land marks for establishing aiming points and compass courses.

Reconnaissances are classified as follows:

Day or *night*, depending upon the time when they are made.

Preliminary or *in force*, depending upon the number, character, and strength of the force engaged.

Close or *long range*, depending upon the distance of the vessels from the fortifications.

Day reconnaissances are made for the purpose of locating the different elements of the defenses and testing their strength; to determine the effective and dead areas of the armament, and to locate and chart aiming points and compass courses.

Night reconnaissances are made for the purpose of locating mine fields, marine obstructions, and searchlights.

Preliminary reconnaissances are usually undertaken by torpedoboats, detroyers, and light cruisers, which, because of their great speed, offer difficult targets, can deliver a fairly heavy fire and be quickly withdrawn.

The vessels are usually scattered over the water area and engaged in a desultory fire, without expecting to inflict serious damage, hoping to "draw fire" in return and escape without injury; they are usually made in the dusk of evening or at early dawn. If submarines are employed, they take up the most available positions "in observation" near the defenses.

Reconnaissances in force.—Where a fortress commander has stubbornly refused to disclose information concerning the location and strength of his batteries, a reconnaissance in force is resorted to. These are made by battleships and battle cruisers and are usually preceded by mine sweeping and screening details of destroyers.

The naval commander by a feint attack may engage the defenses with a heavy fire, concentrating it upon some feature of the fortifications whose location is known, and endeavors to impress the fortress commander that a genuine attack is being made and to cause him to reply with all or some of the batteries and thus disclose their positions. Having accomplished his purpose or being convinced of his inability to do so, he will withdraw.

Short and long range reconnaissance.—Most reconnaissances, except those undertaken by submarines, will begin at long range, hoping to elicit the desired information with as little risk as possible. When, however, this cannot be accomplished from a distance, the vessels will gradually close in, getting nearer and nearer the defenses, and thus a short range reconnaissance will result.

Short range reconnaissances are also those which result when the vessels approach close to the defenses in thick weather or at night.

DEMONSTRATIONS

This class of operation has for its object:

a. To harrass and wear out the personnel of the garrison by frequent feint attacks.

b. To force an expenditure of ammunition.

c. To cover, or distract attention from, vessels engaged in a real attack, landing or embarking of troops.

RAIDS

These are attacks made upon some more or less exposed element of the defenses, or one whose destruction is considered necessary for the successful prosecution of further operation. They are usually covered and protected by a demonstration against some other part of the works.

The purposes for which a raid might be made are almost unlimited, but are always undertaken for some specific purpose and against a particular element or part of the defenses.

The following are some of the most important purposes for which raids are made:

a. To destroy marine obstructions and mine fields and clear a passage through them.

b. To destroy observing, signal, and range-finding stations, searchlights, etc.

c. To destroy or silence some particular battery or group of batteries whose fire is particularly effective.

d. To cut communication and mine cables.

e. To land detachments for any of the above purposes.

BOMBARDMENTS

The strict definition of bombardment is a continuous or prolonged attack by artillery, directed upon a place which is unfortified and which cannot return the attack, such as the buildings of a city, a naval yard, or shipbuilding plant, with the object of their destruction or to persuade a surrender or capitulation. This meaning, however, has been broadened so as to include the attack of war vessels upon, or engagements with, coast fortifications, which can and do reply with artillery fire, generally of the same class.

Bombardments of fortifications are attacks made with the intention to destroy them, or to seriously damage them to such an extent that a passage can be made by them to the city, shipyard, naval base, or fleet which they protect.

Bombardments are always a prelude to and part of a run-by.

RUN-BY

This is the fleet, or a part of it, forcing itself through the mine fields and past the fortifications.

Some authorities are inclined to the view that a run-by is too hazardous an operation to be attempted because of the serious losses likely to be incurred and the necessity of again effecting a run-by to gain the open sea. Such a view is effectively answered by balancing losses against gains. If the goal to be reached is of greater value than the estimated probable loss, the attempt will undoubtedly be made.

Attempts to pass submarines, destroyers, or torpedoboats by the fortification will always be a probability. Such transits will, however, be under cover of thick weather or at night, and will depend upon stealth, rather than force, for their success.

Battle Tactics

The various forms of naval attacks to be expected have been outlined. A tactical employment of the armament and organization to repel such attacks is presented.

The tactical grouping of armament is made for the purpose of obtaining its most prompt and powerful destructive effect when in action. The tactical units are designed and created to permit the operation and manipulation of the units in accordance with the plans of the commander and afford an efficient means for the will of the commander to be transmitted to each and every individual who is affected by his orders and who is expected to respond to them. When a tactical arrangement accomplishes such results, quickly and certainly, it is effective and may be designated as a *tactical organization.* The employment of such an organization in a naval engagement by coast fortifications constitutes, in part, *coast artillery battle tactics.*

The tactical control begins with the fortress commander, and extends through the fire and battery commanders to the ultimate individuals in the battery who are affected. It is retained by the fortress commander as long as he can communicate with his fire commanders, and by them as long as they can communicate with their battery commanders.

Tactical control depends to a large extent upon the efficiency of the means of communication. This is recognized and provided for by making the battery the basic tactical unit and providing a *general defense plan* to be followed when communication fails.

In reference to the various naval operations previously discussed, the following may be assumed as a logical sequence:

1st. Selection and occupation of the base of operations.
2nd. Establishment of the blockade.
3rd. Reconnaissances.
4th. Demonstrations and raids.
5th. Bombardments.
6th. The run-by.

THE BASE

In selecting a base of operations the naval commander will be governed by many considerations, such as proximity to the fortifications against which he is to operate, a suitable harbor to accommodate the fleet and afford facilities for repairing, coaling and transferring supplies, affording natural means of defense, etc. The base will most probably be beyond the range of the guns of the fortifications and its selection will have an influence on the defenses only as they are affected by its proximity, and furnish a lair from which the enemy can sally forth to deliver his attacks and to which he can retire for recuperation.

THE BLOCKADE

The duties of the fortifications during a blockade depend wholly upon the purpose for which the blockade has been established. If it is established solely to prohibit the egress and ingress of commerce, or is an outward blockade to prevent the use of the harbor by the home fleet, the rôle of the fortifications will become passive. On the other hand should the fortifications be charged with the duty of protecting a naval force with its defenses, its duties are active; under such circumstances the hostile navy will adopt all kinds of operations to destroy the usefulness of the ships behind the defenses. This may be attempted either by a bombardment, run-by, or passing submarines or destroyers by stealth through the defenses or, failing in these, to block the harbor entrance, and it will then be necessary to exercise defensive functions of the highest order to keep the hostile navy at arms length; the ability to do this will test the strength of the defenses and the generalship of its commander to the extreme limit.

The tactics to be employed against all of these operations except the last will be treated under their appropriate headings. The latter is a form of operations which is peculiarly connected with a *blockade* and requires separate consideration.

It may be accepted as a principle that the enemy will not risk vessels within the range of the guns of the fortifications without an object. When he does come within range, it is the duty of the fortress commander to discover his purpose and to defeat it. It follows then that a blockading fleet should be compelled to respect the offensive powers of the fortifications and remain beyond the range of the armament. The ability to enforce this condition is a direct function of the accuracy of fire of the armament employed for the purpose. We have available for this purpose the primary armament: guns and mortars.

Mortars are the proper weapon to employ for this purpose. Shot for shot, guns possess a greater accuracy of fire, but less range and destructive effects. They disclose their position and can be subjected to a return fire. Mortars, shot for shot, possess less accuracy of fire, a greater range and destructiveness, do not disclose their positions, and cannot in general be subjected to a return fire. When fired in salvos, by pit or battery, their accuracy is greater than that of guns, and their moral effect to accomplish a withdrawal of the enemy will be exceedingly efficacious.

Single shots should be fired with care and deliberation. All base lines should be employed to plot the errors and transmit them to the battery firing. Should the enemy stubbornly refuse to depart or it is expedient to damage him, salvos should be resorted to and gun batteries may be put into action.

The feasibility to block a harbor entrance depends upon its physical features. The ability of the defense to frustrate such attempts depends upon the volume of fire of the intermediate armament, the efficiency of the searchlights and of the outer harbor patrol to promptly and timely discover the attempt when made. The most probable means to be employed in blocking a harbor entrance would be by sinking merchant vessels or barges in the narrowest part of the channel. All attempts to do this will be made under the cover of darkness and the most favorable weather conditions. Every effort should be made, and of course will be made, to discover any attempt by the enemy to approach the harbor entrance.

When the defense has reason to believe that it is of advantage to the enemy to close the entrance, additional precautions and means should be taken and special efforts made to discover his movements as early as possible. It is important to destroy the barges or vessels to be used in closing the channels; it is equally important that they be destroyed and sunk in some place other than in the channel. For this reason mines should not be used, main dependence being placed upon the gun fire of the intermediate and secondary armaments.

It is most improbable that war vessels of any kind would be used for the purpose of closing a harbor entrance. As soon then as vessels approaching the harbor have been classed as merchantmen or barges and they are not in a critical part of the channel, every effort should be made to sink them immediately by directing all the intermediate and secondary armament upon them. If this volume of fire is believed to be inadequate or proves ineffective, the defense commander should *not hesitate to employ the guns of the primary armament.*

This use of the primary armament may not be concurred in. It is true that the secondary and intermediate armament can and no doubt will sink vessels of this class, but their destruction is not all that is desired, the enemy himself contemplates this, but the place at which they *are sunk* is equally important. If they are *not in the channel* that is the locality in which to sink them and the *time* is to do it *then*. Further it should always be a principle of defense to prevent the enemy from accomplishing his purpose, to this end all the elements of the fortifications are available; to neglect or fail to employ any or all of them when necessary to secure a defeat of the enemy's purpose, shows a lack of appreciation and understanding of his duties on the part of a commander.

RECONNAISSANCES

By threatening maneuvers and feint attacks the enemy endeavors to draw the fire of the batteries and thus cause them to disclose their positions, character, and strength; also to locate by observation range stations, searchlights, batteries which are not in action, and other elements of the defenses. A due regard for the safety of his vessels will constrain the naval commander to exercise great care and caution in selecting the class of vessels to be used for reconnoitering, so as to incur the minimum risk consistent with a successful elicitation of the information sought. Upon the amount and character of the information obtained will depend his further operations and methods of attack; upon its accuracy, his success or failure.

The necessity for making a reconnaissance depends primarily upon the mission and character of operations to be inaugurated; also, but to a less extent, upon the reliability and amount of information already possessed. If this information be incomplete or of a doubtful value, thorough and extensive reconnoitering will be required.

It is a self-evident fact that when a reconnaissance is undertaken the enemy needs the information he seeks, the character and value of which can be surmised from his persistency and the manner of making the attempt to obtain it. He must have a good, clear idea of the location of the various elements of the defenses before he can hope to attack them successfully, or damage them to any great extent. He cannot waste ammunition in an attempt to do this by indiscriminate firing. Furthermore, unless he knows the location of the batteries and their fields of fire, he must risk the possibility of a surprise and destructive attack even though he suffers an irreparable loss.

It may then be stated as a fact, that when a naval commander has any other mission than one of blockading, careful and thorough reconnoitering cannot be dispensed with, but must be intelligently and systemmatically carried on until he gains that degree of knowledge which will justify him in subjecting his fleet to losses commensurate with the success he hopes to obtain by engaging in an attack.

Since the advent of the submarine, it has been extensively used for the purpose of reconnoitering, and to a more or less extent has displaced the fast moving destroyers and torpedoboats. Due to its ability to travel submerged, it can approach the fortifications without being seen and take up a position from which it can make observations and locate the various elements of the defense. By carefully selecting some position in a headland shadow, obscure cover, or other advantageous place for concealment, it may either come to the surface or expose only its periscope and avoid discovery for a considerable length of time. From such a position it may be able to locate and chart the different elements of the defenses, and escape with the information without harm or discovery. Such means of reconnoitering are extensively used, very efficient and most difficult to detect. In the day-time, batteries, stations, and land marks can be accurately plotted and at night searchlights easily located.

Reconnaissances by submarines may, or may not be made under cover of a demonstration, depending entirely upon the ability and efficiency of the defense to operate against them.

A reconnaissance is a most serious phase of naval operations for the fortress commander. By its employment the naval commander endeavors to learn some important fact concerning the defenses, or to verify doubtful information, and, whenever engaged in, some information is always disclosed to him. Whatever the amount or character of the information thus gained, it is just that much less to the defense. That the information sought is important cannot be doubted for a naval commander will not needlessly subject his vessels to possible damage. It, therefore, behooves the fortress commander to zealously guard against disclosing all information concerning the elements of the defenses, and especially that of the important batteries of the primary armament and searchlights.

The naval commander must of necessity require a certain degree of knowledge of the defenses before he can intelligently operate against them, or seriously engage them with an idea of their destruction, or effect a run-by. The more stubbornly and effectually such knowledge is denied him, the more secure are the defenses.

Throughout a reconnaissance the naval force will assume various formations and execute confusing maneuvers and evolutions, employ smoke screens, etc., some for tactical reasons and others solely for the purpose of confounding range observers and gun pointers ashore. He will run courses as though he intends to force a passage or attack the mine fields, and it will be a wise and skillful commander who is not misled by him.

Just as a fortress commander can be induced to disclose to the enemy the very things he is most desirous of concealing, so also can he mislead and deceive the naval commander by false information. Such false information is most easily and readily imparted by constructing dummy trenches and emplacing obsolete or wooden guns in them; by the erection of false range and searchlight stations, etc. Subterfuges such as these, when skillfully constructed and well placed, will draw a tremendous volume of fire and exhaust a considerable quantity of ammunition.

We have seen the necessity for reconnaissances and understand their importance to both the defense and offense, and learned in a general way how they are conducted. How best may they be circumvented? What are the best tactics to employ to inflict a severe punishment if the enemy becomes too bold and persistent in seeking information, and at the same time disclose no information to him, or as little as possible? Such questions as these are constantly before the fortress commander and must be answered by him.

His first duty is to estimate the situation as presented and decide what character of operation the naval commander is inaugurating. If it is a reconnaissance, the most natural and efficient thing to do is to make no reply whatever to the attack. A passive defense of this nature, though, may not always be a possible or proper one to assume. If the enemy's fire is causing an appreciable damage, a consideration of the amount and its effect on the defenses should be balanced against the amount and value of the information which would be disclosed to him by attempting to drive him off. If the damage becomes serious and he must be driven away, those batteries which are most conspicuous and whose location he probably knows should be put in action against him.

If he becomes too bold and daring in his attempts to gain information, advantage should be taken of any favorable opportunity to inflict damage. Before determining to do this, however, it is best to carefully consider and weigh the situation and decide if the opportunity presented promises more chance of success for the destruction of a vessel than failure. If it does, it should be accepted, and all batteries of the proper class to cope with the vessel, especially those which are prominent or whose location it is difficult to conceal, should be ordered to prepare for action. The vessel selected for destruction should be assigned as the target, the batteries loaded and trained on it, and at the most auspicious moment all of them should open fire simultaneously and continue firing until the vessel is destroyed.

The suddenness of such a concentrated attack is conducive of the best material results and is very disconcerting; being delivered from many different locations and directions at the same time will make most difficult the ability of the enemy's observers to definitely and accurately locate the batteries firing; further, the concentrated fire on a single vessel should result in its quick destruction. As soon as the vessel is destroyed, the firing should cease until another opportunity presents itself. The batteries or fire commands engaged should not be allowed to change to another target as this form of attack depends for its success upon the delivery of fire from many directions and upon the suddenness of the attack to prevent accurate reconnaissance.

This tactical principle is applicable for attacks upon any type of vessel, but the kind of armament to employ requires consideration and depends on the range and class of vessel to be attacked.

Having identified and classified the vessel and found its range, the armor attack sheet will show what armament can perforate its side and deck and the probable number of hits required to destroy it. The amount of armament to put in action depends upon the length of time the vessel can be covered by a destructive fire and the probability of hitting at that range. As the destruction of one vessel is particularly desired for punitive effect, a large factor of probable destruction is desired. This requires that the amount of armament to be employed should be excessive rather than otherwise.

If the loss of one vessel can be effected during each reconnaissance with the disclosing of a minimum amount of information, the naval commander will, if he attacks at all, be compelled to do so with a deficient knowledge of the defenses and with a reduced force.

A patient with-holding of all fire is greatly to be desired, and it should be held as long as possible. Batteries should be put into action only in case of necessity to prevent damage, or when a material or serious injury can be exacted as a price for disclosing their position. A patient with-holding of fire at the beginning of a reconnaissance will also inspire the enemy with a confidence that he cannot be successfully attacked, that your ammunition supply is not plentiful, that your armament is ineffective at the range and place from which he is operating; or other conclusions may be drawn by him in receiving no reply to his fire. But whatever these conclusions might be, they will each impress him with the fact that he must close in, otherwise he will not obtain the information which he has set out to get; and realizing that he must draw fire, he will close in until his fire is effective against the defense. When he is well within effective and destructive range of the fortifications, he should be dealt with.

When the enemy is engaged in a reconnaissance in force, he generally takes up a position at extreme range and directs his fire upon range stations, searchlights, and those batteries whose location he has discovered, endeavoring to draw the fire of the guns of the primary armament. If he is unsuccessful in his attempts to draw fire, he will close in to just beyond effective range of the intermediate armament, when his fire will most likely become effective and it will then be necessary to drive him off to prevent serious damage.

Since reconnaissances in force are undertaken only when energetic action is necessary, the enemy may close to less than seven thousand yards, although the usual range will be from eleven thousand to fifteen thousand yards. As the armament of the ships engaged in a reconnaissance of this kind is of the largest caliber and power, the damage done to the defenses will be serious whenever hits are made on important works or stations and a passive defense will be most difficult to maintain.

Mortars should be employed for the purpose of repelling a "reconnaissance in force," using a concentrated fire upon the largest and most important unit of the fleet. The information disclosed will be of very little or no value, for even if their positions are discovered they cannot be replied to, while their fire is fairly accurate, extremely destructive, and has a very great deterring moral effect. No vessel can remain under a concentrated mortar fire for any length of time and escape destruction. However, those gun batteries of the primary armament whose location is known, or cannot be concealed, may be permitted to go into action. Such batteries can readily be determined by the fall of projectiles on them or in their vicinity. The enemy cannot waste ammunition and naturally would direct his fire where he knows or has reasons to believe a battery to be located.

All fire commands of the intermediate and secondary armaments should be prepared to attack submarines, and all observers not actually engaged in range finding should be required to look out for them.

DEMONSTRATIONS

These are commonly known in land warfare as covering, holding, or feint attacks, the purpose of each being very much the same in naval operations, to which they can be readily compared.

A demonstration made to cover some other kind of operation usually selects for its point of attack those elements of the defenses which are designed and installed for the protection of the point or place against which the real attack is to be delivered. The vessels engaged in the demonstration endeavor by their fire to nullify or overcome those batteries or means of defense which are engaged in repulsing the landing, reconnoitering, or raiding force. Such batteries or means of defense should not be diverted from their true rôle and allowed to direct their energies upon the vessels engaged in the demonstration. Their entire offensive capacity will undoubtedly be required to defeat the attacking force, and any division of their offensive powers will better enable the enemy to succeed in his undertaking. The force which attempts to land, reconnoiter, or attack is the objective against which all available armament and energies should be directed. Batteries which cannot be employed for this purpose should direct their fire upon the covering vessels.

Demonstrations made for the purpose of wearing down the personnel are frequent attacks made at irregular intervals and throughout a considerable period of time, the idea being to cause a continuous manning of the defenses and prevent the troops getting a proper amount of unbroken rest. This form of operation can be made very distressing, and if proper means to counteract its harmful effects are not taken, may lead to carelessness on the part of the personnel and result in allowing the enemy to inflict a serious damage by a surprise attack or accomplish a successful run-by. On the other hand if it is permitted to needlessly harrass the troops, serious discontent will arise. So between carefully watching the enemy and conserving the vigor and contentment of the garrison, the fortress commander will be required to exercise considerable administrative ability.

As soon as the intent and design of the enemy becomes evident, an organization should be perfected by dividing the troops into reliefs and a regular roster operated so that only a part of the defenses will be manned in case of alarm. In case an attack becomes too energetic, signals should be provided for calling out the second, third, or fourth reliefs, and so on as they are required. The idea being to divide the troops into as many reliefs as possible so that each will add only a small increase to the manning detachments. Means for sounding a general alarm should also be provided. Such an alarm should not be made unless it was positively known that the enemy has been definitely committed to an attack which will require all the armament to repulse.

Demonstrations to force an expenditure of ammunition will only be undertaken when the enemy is well convinced that the supply on hand is limited and there are no means by which it can readily be replenished. Should fortifications be found in such circumstances, there is but one mode of operations possible and that is to *count every shot and to make every shot count.*

The available ammunition should be placed at the disposal of the most powerful and useful batteries; and such batteries manned by the most efficient and skillful personnel, transferring to them officers and men from those batteries which have no ammunition, and every means taken to increase their accuracy of fire and efficiency.

Those batteries which have no ammunition should be manned and operated with reduced blank charges, if powder is available, to create the impression that they are in action and thus hide the true state of affairs. A certain amount of black powder should be mixed with smokeless or used alone to better attract attention to them.

RAIDS

This form of attack is generally delivered with suddenness and is usually of a very intense and violent character, depending to a great extent upon surprise and a preponderance of force for success.

Small parties sent ashore under cover of darkness, or favorable weather conditions, for the purpose of destroying isolated elements of the defenses with an intention of reembarking as soon as their mission has been completed, are also classed as raids.

Raids, unless made in thick weather or under cover of darkness, are usually protected and covered by a demonstration to divert attention and cause a division of the fire. To be successful, they must be made under conditions that will enable the vessels to approach well within the range of their intermediate armament.

Night time, of course, will be most favorable for operations against searchlights and mine fields, although attacks may be expected in exceptionally thick weather during the daytime.

BOMBARDMENTS

Coast fortifications are erected to prevent bombardment, and are usually but not always placed sufficiently far in advance of the place to be protected to accomplish the purpose. When not so placed, the area from which a naval bombardment can be effected should be covered by the fire of the defenses.

Bombardments, as applied to naval attacks against fortifications, have for their purpose a destruction of the fortifications, in which all the armament and offensive powers of each are brought into action. This form of attack might be termed the duel and should be met by the employment of all armament. The fire should be distributed as nearly as possible over all units of the fleet so that every vessel would be under fire from some batteries, otherwise the opportunity to cause a detrimental moral effect and to destroy the fire discipline of those vessels which are not under fire will be lost.

For the purpose of bombarding, the enemy will usually divide his force into two or more wings, each moving in irregular formations, with varying speeds and courses, the idea being to confuse observers and prevent accurate range finding.

The range from which bombardments are undertaken will vary, and depends to a large extent upon the conditions of the defenses and especially upon the efficiency of range finding. If the defenses are weak or their offensive power has been impaired, or the range finding systems more or less damaged, the fleet will close in so that their intermediate armament may become effective, otherwise it will bombard from the effective range of their primary armament.

Where a fleet can bombard a city, or other important place in rear of the fortifications, a part of the fleet will be assigned for that purpose, and a part to engage the fortifications. Under such circumstances, the vessels which are engaged in the bombardment proper should be made the object of attack. Batteries which cannot be effectively or profitably so employed, should direct their fire upon the vessels engaged in the demonstration.

THE RUN-BY

Through bombardments, various forms of raids, demonstrations, and other attacks, the enemy having endeavored and labored to destroy the fortifications or place them in a more or less impotent condition, will undertake a run-by. This is usually the final or culminating direct operation and when successfully accomplished, the power of the fortifications to furnish protection for those places behind it has been lost, and their usefulness as a means for further military operations may be quickly and easily destroyed.

To make a successful run-by, the enemy must first damage the defenses to such an extent that the probable losses to be incurred during the run-by will be more than fully repaid by the goal he expects to gain. A run-by is only undertaken after a thorough preparation by heavy bombardments, or as a surprise. Favorable weather conditions such as fog, snowstorms, winds, and darkness will be selected as the time when to make the attempt; and these conditions will be further enhanced by a copious use of smoke screens.

The formation for a run-by will be that of one or more columns, flanked by destroyers and torpedoboats on the windward side, or having approached in single column may, when well screened by smoke, form a double or as many more columns as the channel will permit. They are always made at the maximum rate of speed, and all armament is put into action against the fortifications as soon as possible. If the formation be of more than one column, the columns will approach the entrance from different directions and be so timed as to arrive and go through together in a line of columns. As many columns are formed as the width of the channel will permit so as to pass the fleet quickly by the fortifications. All vessels will engage the fortifications vigorously as soon as they come within range and continue the bombardment after passing; those first through will turn out of the column, slow down and take up positions from which they can attack the forts in reverse.

If the fleet approaches in one or more columns, the leading ship of each should be attacked. All armament should be brought into action and all fire concentrated upon them so that if their speed is affected, they must turn out of the column or slow down and thus delay ships in rear. If there be three or more columns, the leading ship of the center column should be attacked. To permit formations of more than two columns the channel would have to be of considerable width and probably will have fortifications on both sides. The enemy, very naturally, then, would place the lightest armored vessels in the center and by destroying the leading vessels of such columns, or causing them to turn out of the column, will greatly increase the probability of throwing the other columns into confusion and disorder to avoid collisions. If any vessel is halted, or beached, it can be dealt with later. If it is sunk, it blocks the channel; and ships in rear must make a detour to avoid it and thereby derange the whole formation.

Should the run-by be made to provide safety for troopships, all the armament should be concentrated on the transports. If conditions are such, due to smoke screens, fog, or darkness that the transports cannot be seen beyond the columns of protecting ships, it is good tactics to have at least part of the armament fire with an increased range, the purpose being to sweep that part of the channel occupied by the transports. Such increase can be determined from a study of the hydrography of the passage.

A very high observation station, or captive balloon would be invaluable for observing the fire during a run-by, especially if the obscuration be due to smoke screens or a low fog. A suitable and efficient station may readily be improvised by the use of an extension or aerial fire ladder, such as are furnished to all posts.

The run-by is not only a possible naval operation to be undertaken against coast fortifications, but a most probable one. History is replete with successful operations of this kind. A most notable one, and one well worthy of study, was that made by Admiral Farragut when he forced a passage by Forts Jackson and St. Philip, which guarded the Mississippi River below New Orleans.

These forts were placed at Planche-mine Bend in the river and were only 800 yards apart. Besides the forts there was also a floating defense consisting of two iron clad rams, the *Louisiana* and *Manassas*, and four gunboats, all of the regular navy, and a fleet of about six gunboats manned by volunteer rivermen. The river was obstructed by old hulks, connected together by means of several heavy chains, which made a most formidable obstruction. The use of fire boats and fire rafts was also resorted to and effectively employed. Certainly this was a very formidable defense, yet it was successfully passed in a little over five days. Operations to clear the passage began at 10 o'clock P. M., April 20, and on the morning of the 25th, the fleet had passed and was anchored five miles above the forts, and on the morning of the 28th the forts surrendered.

The fleet which accomplished this run-by consisted of five sloops of war and nine gunboats, all wooden vessels and mounting 154 guns of all kinds. A flotilla of twenty mortar schooners mounting one 13-inch mortar each and a convoy of six gunboats remained below the forts and bombarded, but their fire was unimportant and did not interfere with the effective use of the guns of the forts during the run-by.

The opposing armament was as follows:

Fleet	*Fort. St. Philip*	*Fort Jackson*
13 11-inch S. B.	5 8-inch S. B.	25 24-pdr. S. B.
2 10-inch S. B.	1 7-inch rifle.	10 24-pdr. howitzer.
84 9-inch S. B.	6 42-pdr. S. B.	3 10-inch S. B.
23 8-inch S. B.	9 32-pdr. S. B.	5 8-inch S. B.
1 100-pdr. rifle.	21 24-pdr. S. B.	1 7-inch rifle.
3 80-pdr. rifles.	7 mortars, 8-, 10-, and 13-inch cal.	2 32-pdr. rifles.
1 40-pdr. rifle.		6 42-pdr. S. B.
16 30-pdr. rifles.		15 32-pdr. S. B.
8 32-pdr. S. B.		
3 20-pdr. S. B.		

Total armament: fleet, 154 guns; forts, 109 guns, 7 mortars.

The floating defense comprised the *Louisiana* of 16 guns, probably only 8 of which could be used, the *Manassas* and four gunboats carrying 12 13-pdrs. and 1 9-inch S. B., in addition to the armament of the gunboats manned by the volunteer rivermen, which may be neglected.

Thus we have a fleet of 14 vessels mounting 154 guns—all of which could not be used as the fleet went by in double column formation—to contend against two forts and a floating defense, mounting about 130 guns in all, a formidable obstruction, and fire crafts.

There is no marked discrepancy between the armaments; there was no racial difference or superior moral courage or fighting efficiency possessed by the personnel of either side; the forts, floating defenses, and fire rafts apparently were well and skillfully handled and fought; yet the passage was made and a junction of the army and navy above the forts forced their surrender by cutting communications with New Orleans.

It will be noted that the army co-operated with the navy and forced the surrender; the army took no part in the attack on the forts nor did it assist in the run-by in any manner; this was a *naval operation* solely and completely.

In the present European war the navies of England and France have attacked the Dardanelles for the purpose of destroying them. As a run-by was not attempted, there is no reason to believe that if it had been, it would not have been successful. There was nothing to gain by such an operation without an army to cut communications by land. Such a force was not present until the latter part of the operations and it failed to sever communications. Had it been successful, the navy could and would have forced a passage and the fortifications would have quickly fallen.

The armament of fortifications is seldom replaced until worn out. It is usually outclassed by that aboard ships. Especially is this so since the advent of the superdreadnought with its high speed, heavy armor, and an armament as powerful as that of any fortification. Certainly conditions suc has these are, bid fair to make the run-by not only a possible naval operation but a most probable and successful one. It is doubtful if an example can be found in naval warfare where a fleet of sufficient strength to cope with the fortifications, having made a serious attempt to force by, has failed. What has been accomplished in the past will certainly be attempted in the future, if conditions are such as to require it. It is necessary, then, to expect such operations, to prepare for them, and to consider them not only as a possible but as the most serious form of attack which will be made.

It has always been more or less a theory held by coast artillerymen that a naval force will not alone attempt to reduce well armed and efficiently served fortifications unless supported by a land force. It is believed that the best naval authorities incline to the further view and assert that a fleet should be used only as an adjunct to land forces in the reduction of such a fortification. This principle seems well founded and many examples have occurred in the more recent wars which confirm it. In the Russo-Japanese war the capture of Port Arthur required a large army for its reduction while the fleet was content to blockade from the sea, being unable or unwilling to attack. It is true that raids were made against the Russian fleet in the harbor by destroyers and torpedoboats, but no naval attempt was made to reduce the fortifications. In the Spanish-American war, Admiral Sampson was content to wait for the Spanish fleet to be forced out of Santiago harbor by the army under General Shafter. He made no attempt to reduce the fortifications or to force a passage, although the defenses were known to consist of a meager and obsolete armament.

The most recent and convincing proof of this principle, however, is to be found in the present great European war. A combined fleet of the English and French navies, practically of unlimited strength, comprising vessels of the latest type and mounting the most powerful armament ever floated, was sent against the Turkish defenses of the Dardanelles and has suffered a disastrous defeat.

This attack was dictated by the most important and highest strategic reasons, military, political, and economic. That it was stubbornly and determinedly made is evident from the naval losses, which, while not fully disclosed, include five battleships, many cruisers, destroyers, and smaller vessels. That it was a dismal failure as an attempt to destroy the fortifications, or to materially damage them, is certain and self-evident by its abandonment.

The foregoing examples show that there is no kind of operation which will not be undertaken and vigorously prosecuted by a powerful and efficient navy against coast fortification. That some were not successful is no argument that such operations will not be undertaken in the future. The underlying reasons which prompt them may not be known, but reasons just as great and influences just as powerful will again exist and, when they do, such operations may be confidently looked for in the future as in the past. They are possibilities which must be anticipated and provided for.

METHODS OF EXERCISING CONTROL DURING AN ENGAGEMENT

Battle tactics, as before stated, include a controlling and directing of the fire action of various batteries of a fortress so as to secure co-ordination and co-operation of them for the purpose of effectively destroying the enemy in the most expeditious and economical manner. There are two general systems or methods by which this control can be exercised.

a. A General Defense Plan.
b. Individual Command.

A General Defense Plan is a series of orders or instructions, comprehensively prepared and issued in advance of, and for use during, an engagement. This series of orders, each complete in itself, puts into action particular elements of the fortress under given conditions, designates the target, the class of projectiles to be used, and the rate and kind of fire to be employed.

The advantages of such a plan are found in the simplicity and certainty of an intelligent plan of action being carried on, a prompt commencement, and a continuance of the action along definite and well thought out plans when communication between the elements of the defenses has been destroyed. It also has the value of written instructions as to what is required and expected; it insures an intelligent cooperation of the various elements of the fortress and conserves ammunition.

A general defense plan finds its best application during a bombardment or run-by. It is during such an engagement that communications between the different units of a command are most likely to be destroyed by gun fire, become unserviceable through long use or valueless through excitement and nervousness of the personnel during the stress and strain of battle; the result being independent fire or battery commanders action, most probably the latter. Under such conditions it is undoubtedly the best manner of meeting attacks and to provide a certain, definite, and comprehensive means for doing so.

A general defense plan for bombardments, raids on mine fields, and the run-by should be carefully worked out in detail and thoroughly understood by all fire, mine, and battery commanders and in their possession and stations at all times.

The general defense plan at first consideration may appear as the ideal and perfect mode of meeting these forms of attacks; a careful and thorough study of all possible contingencies and conditions though will prove otherwise. If it were known from what ranges the bombardment would take place or the class and number of vessels that would be engaged, or if the number of columns to be used in a run-by and the class of ships which would compose each were known, this would be true and it would then furnish not only an excellent plan but a simple one. These questions though cannot be answered until the engagement has begun, and are liable to change even then. So, while a defense plan is extremely valuable and important, it can only be considered for these contingencies as a good substitute for individual command.

Individual Command is the exercising of full control and direction over all the elements of the command prior to and throughout an engagement by the fortress commander personally and individually. To exercise such control it is necessary for him to be in constant communication with all the elements of the command; if such communications be broken, the fire commanders assume control and continue the action in accordance with their understanding of his plan of action, and along the lines inaugurated by him. If communications to the batteries be broken, the battery commanders then exercise independent battery action. They, too, should continue the action along the lines initiated by their fire commander or follow the general defense plan for the particular occasion.

The prime and most important duty of the fortress commander is to *estimate the situation*, to draw a conclusion therefrom, and formulate and put into operation a plan of action necessary to defeat the enemy's purpose. He is required to do this when the first hostile movement is made by the enemy. The accuracy of this decision as disclosed by subsequent events and the soundness of the plan of action pursued because of it, as proved by results, will determine certainly and positively his ability and fitness for command.

To form an estimate of the situation does not mean *to guess* at what the enemy contemplates attempting; on the contrary, it means to carefully consider the situation presented, and by a sound process of reasoning, based on a careful weighing of all past events and existing conditions, to form an opinion. Such an opinion, if based on an intelligent consideration of actual conditions, will be very nearly a correct and proper solution of the problem.

When a powerful and hostile fleet is before the fortifications, its purpose is well known. That all the energy and power which it possesses will be intelligently and systematically directed against the fortification is reasonable to suppose. Having then some knowledge of what a proper sequence of operations should be and an accurate knowledge of events that have occurred, a good idea of what the next move will be can readily be devined. A knowledge of the proper use of the different classes of war vessels will give some indications of the character of the impending attack; the formation, course, and number of vessels advancing against the fortress will furnish a further clue. The time of day and conditions of the weather, taken into consideration with these, will undoubtedly determine the character and force of the threatened attack.

Having formed an opinion of the situation, the fortress commander, with a full knowledge of the condition, power, and capability of the armament of the fortifications, will then decide the character of operations necessary to meet the attack. He issues the necessary orders to the fire commanders as to when to begin the action, designates targets, and, throughout the engagement, issues such additional orders as may be expedient or necessary; and, finally, when to cease firing.

Individual command is the proper and correct way to exercise battle tactics. The general defense plan is a most excellent and necessary supplement, but it, to be efficient, must be well prepared and carefully detailed; further, it must be adapted to local conditions. The day of independent battery action passed with the advent of the all-round fire barbette mount, and any coast fortification which engages a fleet composed of the latest type warships will be hopelessly outclassed and outfought unless an efficient control can be exercised to secure a concentrated (or dispersed) and accurate fire.

THE SPERRY SEARCHLIGHT*

COMPILED BY CAPTAIN ADELNO GIBSON, COAST ARTILLERY CORPS, FROM MATERIAL FURNISHED BY THE SPERRY GYROSCOPE COMPANY

The development of the Sperry searchlight arc followed a very eventful experience by Mr. Elmer A. Sperry in electric arc work. A great many years ago Mr. Sperry developed an original arc lamp and dynamo, which he had in operation in Cortlandt, New York, in 1879. The succeeding year he operated a larger machine in Syracuse and Chicago. In 1883 Mr. Sperry had a large number of electric arc light installations distributed throughout the west from his factory and headquarters in Chicago. Following this Mr. Sperry has kept in touch with the arc light situation, and now has developed an arc which is showing the highest light intensity.

The one important essential of the projector searchlight lies in the arc source of light, and it has only been recently that any great advancement has been made in this direction. This improvement in the output of the searchlight of a given size lies in the increase of the specific brightness of the light source, which is the brightness per unit area of the light source. It is this tremendous increase of the light source brightness that makes the Sperry lamps so much more powerful than any of the lamps used in the present standard Army and Navy searchlights.

Up to the present the source of light which has been universally used had been the positive crater of a pure carbon arc. This pure carbon crater has a fairly constant brilliancy of approximately 150 candlepower per square millimeter, and it has been considered that this was the highest attainable brilliancy. It is true that this old standard searchlight arc gives the highest brilliancy obtainable from a heat radiating solid, since carbon has the highest melting point of any known element, but this brilliancy has been surpassed in the Sperry arc by making use, in addition to this heated crater surface, of a superheated vapor or gas produced in the arc. This superheated gas is formed from certain special materials that are powerful light producers and with which the positive carbon is impregnated.

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* See "Test of Searchlight Carbons." Ohnstad, JOURNAL U. S. ARTILLERY, September-October, 1914, and "Searchlight Carbons," Chillas, JOURNAL U. S. ARTILLERY, March-April, 1916.

For the successful use of this bright vapor as a searchlight source, it is necessary that it be concentrated in a very small area. This is accomplished in the Sperry arc by maintaining a very deep crater in the positive carbon and into which crater this bright vapor is kept pressed. This vapor causes the mouth of the crater to emit a very intense illumination running even as high as 500 candlepower per square millimeter, or 320,000 candlepower per square inch. The force used to keep the vapor pressed back into the crater of the positive is the arc flame from the negative carbon, and is similar to the arc flame used in the old standard searchlight lamps. The arc flame appears as a flame of considerable velocity emanating from the negative carbon, and gives but very little light in either the old or Sperry type of arc as compared with the positive crater.

The following tabulation of the specific brilliancies in candlepower per square millimeter, and which is rightly taken as the basis of efficiency-comparison for all arc work, shows this tremendous light intensity of the Sperry arc:

		Candle power per sq. mm.
1.	Ordinary Tungsten filament	2.4 to 5.4
2.	Ordinary Tungsten filament, nitrogen filled	10.0 to 20.0
3.	Tungsten at the melting point (3500° C.)	72.0
4.	Arc flame, ordinary white flame arc	7.0 to 20.0
5.	Surface of crater "spot," flame arc positive	50.0 to 90.0
6.	Crater surface pure carbon average	150.0
7.	The Sperry arc being the candlepower of dense positive vapor in deep crater of a two-flame arc, special projector electrode	500.0
8.	Sun at 30° elevation	775.0

The very high light intensity of the Sperry arc is also indicated by the curves shown in Fig. 1. Curve A shows the candlepower distribution of the old type 36-inch searchlight lamp with a maximum of 42,000 candlepower throughout a comparatively small zonal angle, and curve D shows the candlepower distribution of the present Sperry 36-inch searchlight lamp indicating a maximum of 105,000 candlepower with a very wide angle of high intensity.

Another great advantage which the Sperry arc has over the older form lies in the very great reduction in area of the light giving source or crater. It is possible by using this new type of arc to concentrate the vapor into a crater which has a very much smaller mouth area than heretofore possible with a pure carbon arc of similar amperage. A distinctive advantage results from this reduction in area of crater, in that the angle of spread of the searchlight beam itself is materially reduced and the beam made much more nearly parallel throughout its length. For the standard 150 ampere arc, the diameter of the positive carbon is only 5/8 inch and that of the crater diameter somewhat less. The diameter of the negative carbon is only 7/16-inch and with its small holder casts a very much less

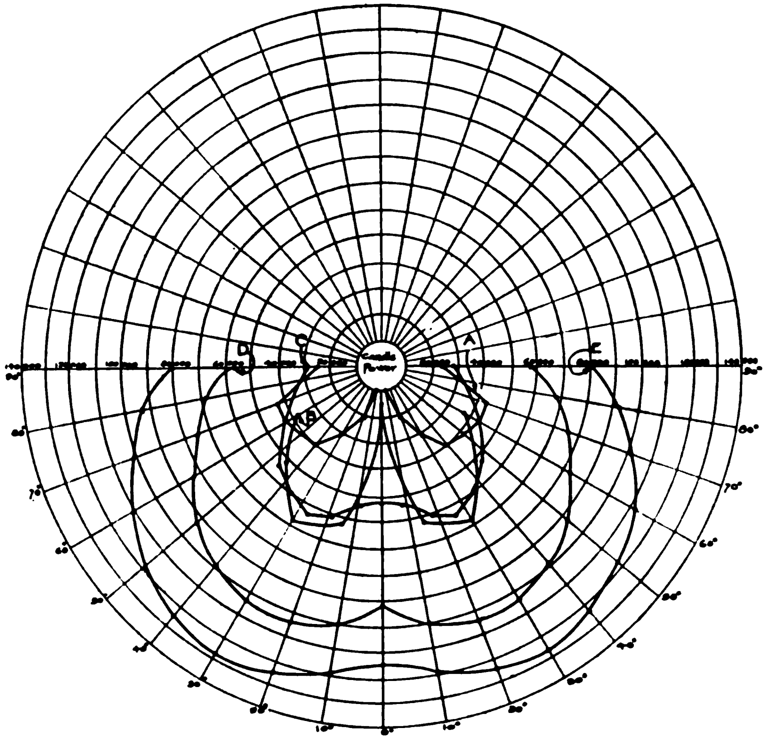


FIG. 1.

CANDLE POWER DISTRIBUTION CURVES

A. PRESENT U. S. NAVY LAMP 36-INCH SEARCHLIGHT
B. " " " " 60 " "
C. SPERRY LAMP 30-INCH SEARCHLIGHT
D. " " 36 " "
E. " " 60 " "

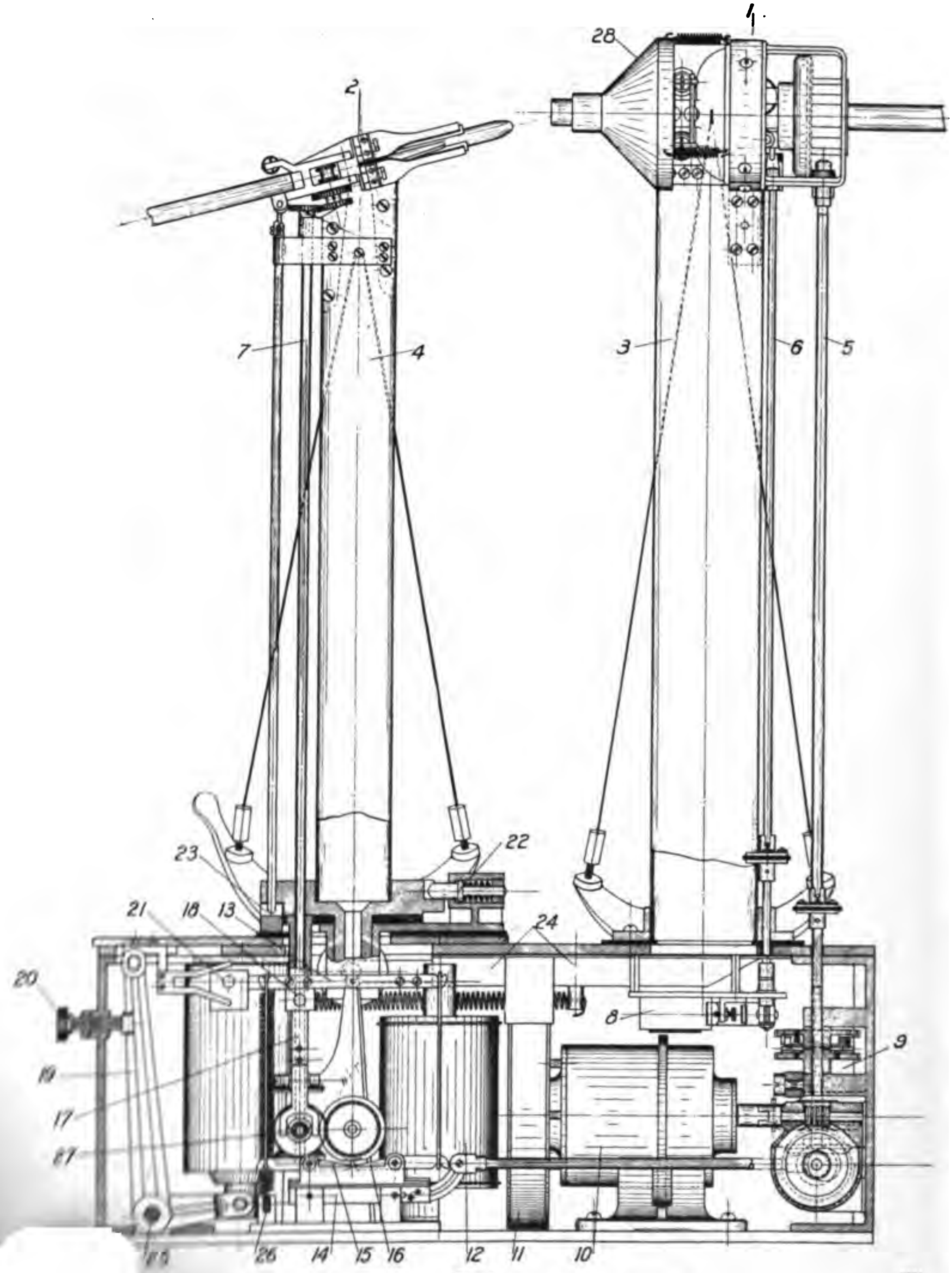


FIG. 2.
DEMONSTRATING DRAWING OF THE SPERRY SEARCHLIGHT LAMP

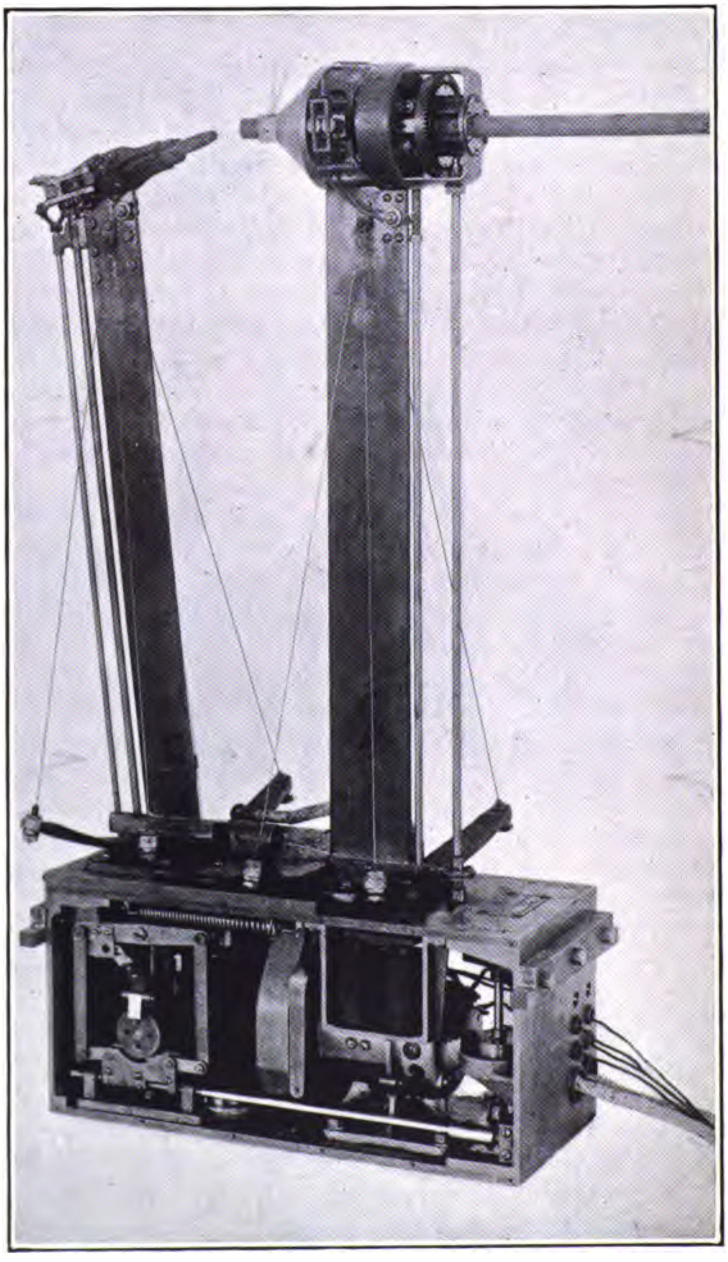
shadow on the center of the mirror, thus, also, adding more reflected light to the beam.

The principle upon which satisfactory operation of this high intensity arc depends now shows itself to be entirely different than previously supposed. It was first believed that current density was the principal factor for the operation of such arcs, but we have found out experimentally by current densities ranging from 100 to 1000 amperes per square millimeter that current density is not the controlling factor, but that current value is the important factor.

It is evident that to obtain this highly concentrated light source and at the same time produce constantly a sufficient supply of bright vapor to fill the positive crater, a rapid consumption of the positive electrode is necessary. It is for this reason that the positive carbons are so much longer than those previously used, being 44 inches for the standard 150 ampere arc. In the old type searchlight arc rapid consumption of the positive was not necessary since the gaseous products were not used at all in the production of light, but in the Sperry type of arc this rapid burning of the positive is necessary to provide the light emitting gaseous materials.

The Sperry Gyroscope Company after two years experimenting with this new form of arc, are now manufacturing projector searchlights giving a candlepower intensity at the arc corresponding to that previously shown in Fig. 1 for 36-inch size, and which with an accompanying reduction in the divergence of the beam gives an illumination on the target of six times that formerly obtained with the older type searchlight of similar diameter.

Fig. 2 shows an elevation of the Sperry searchlight. The control box contains a shunt wound motor (10) direct connected to both a centrifugal blower (11) and a gear train for the feeding and rotating mechanism. The blower furnishes air through passage (3) and (4) to the positive and negative carbon holders respectively. The air supplied to the positive holder is forced between a number of heat radiating discs which surround the end of the holder nearest the arc. The cap (28) is open on the upper side to allow the air to escape from the positive holder. This method cools the positive carbon and also removes the heat from the mechanism of the positive carbon holder received mostly by direct radiation from the arc.



1832

FIG. 3.
SPERRY SEARCHLIGHT LAMP

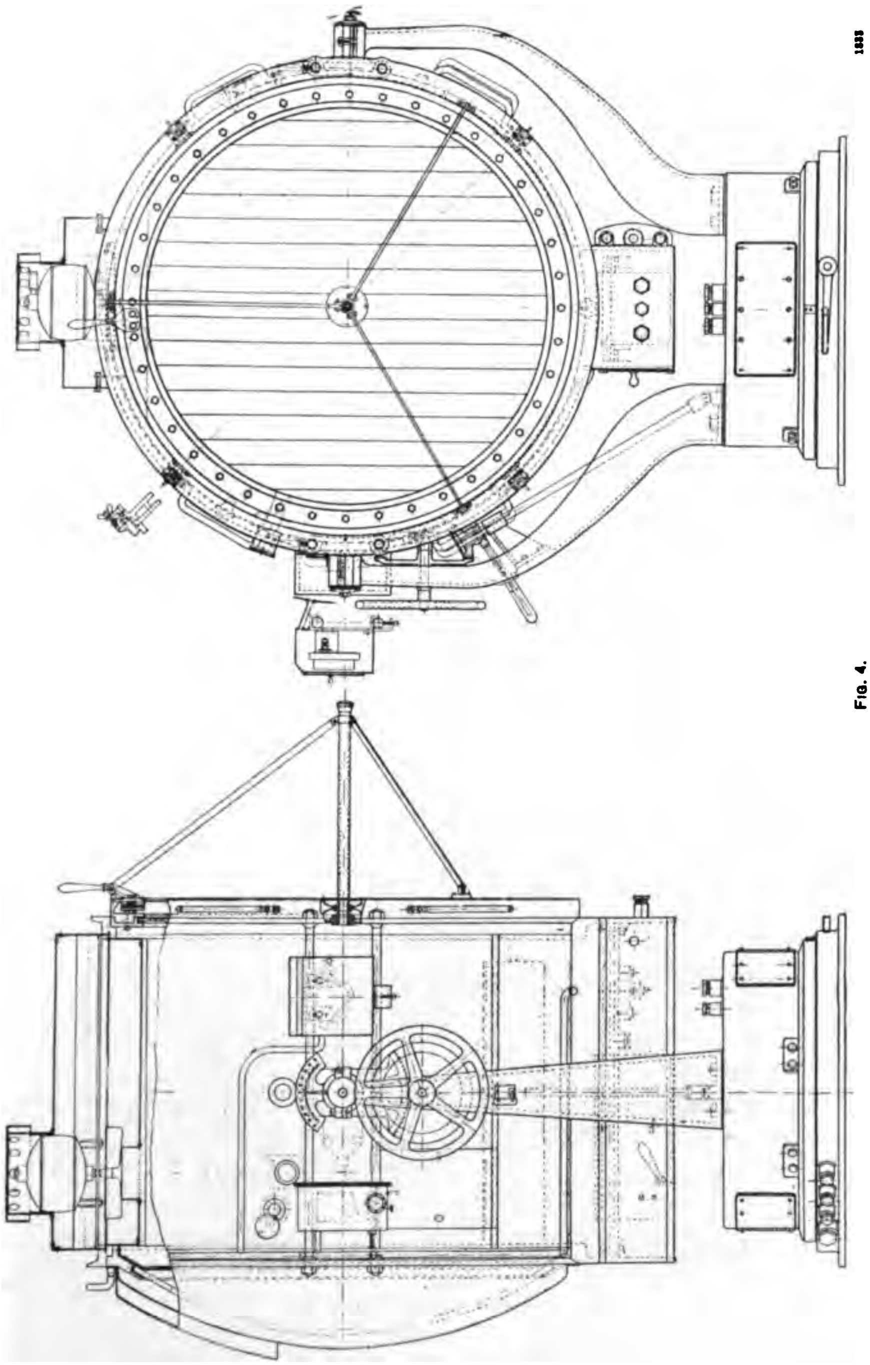


Fig. 4.
Searchlight Drum and Exterior Mechanism of the Sperry Searchlight Lamp

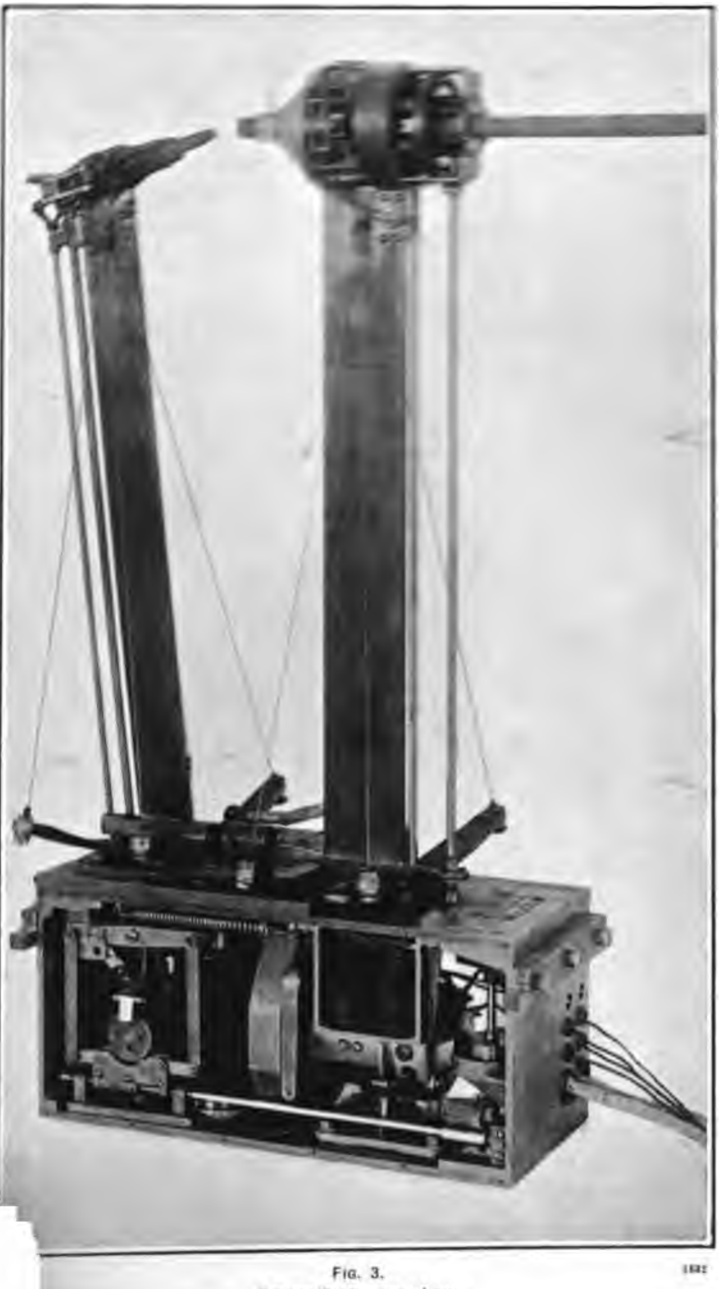
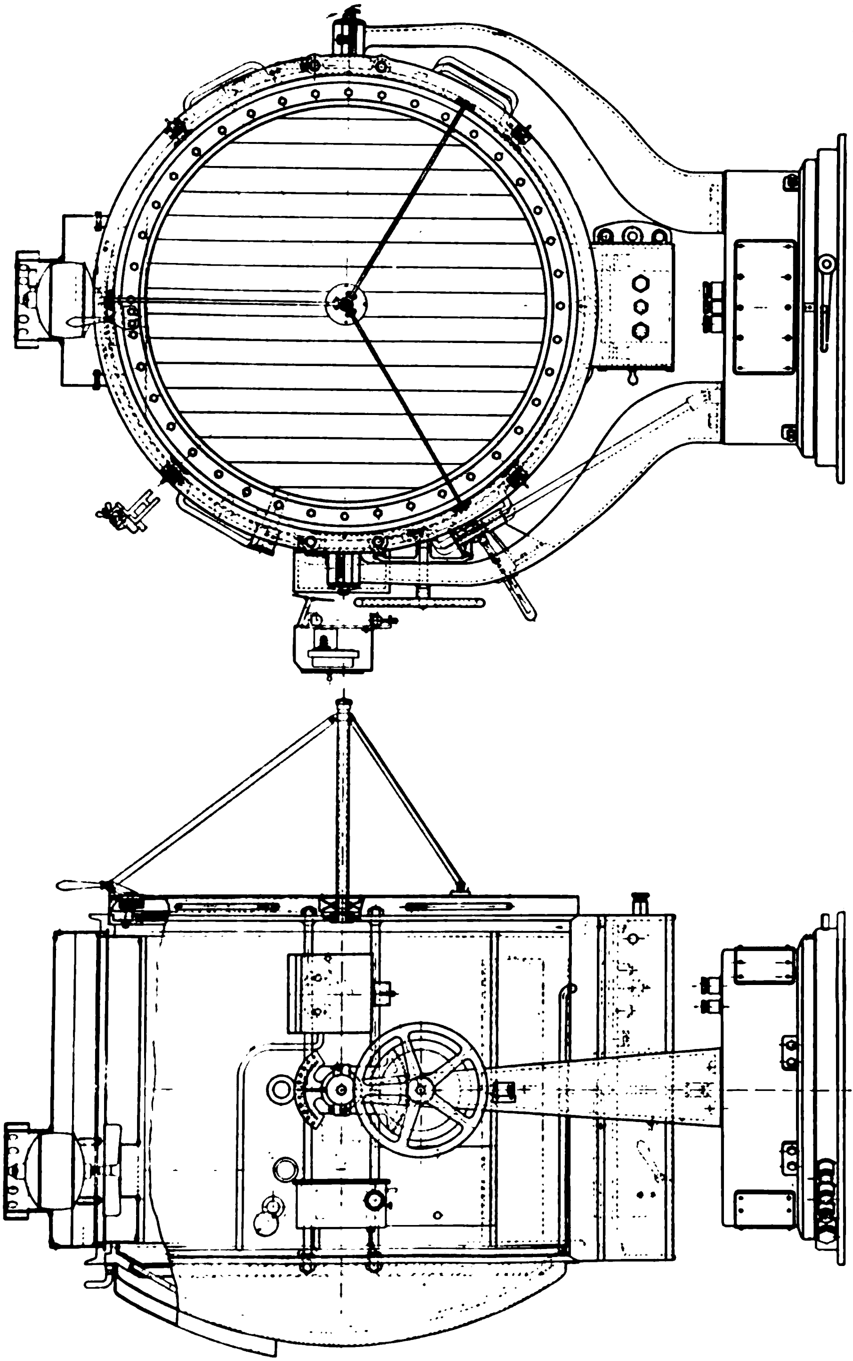


Fig. 3.
Sperry Searchlight Lamp.



1888

FIG. 4.
SEARCHLIGHT DRUM AND EXTERIOR MECHANISM OF THE SPERRY SEARCHLIGHT LAMP

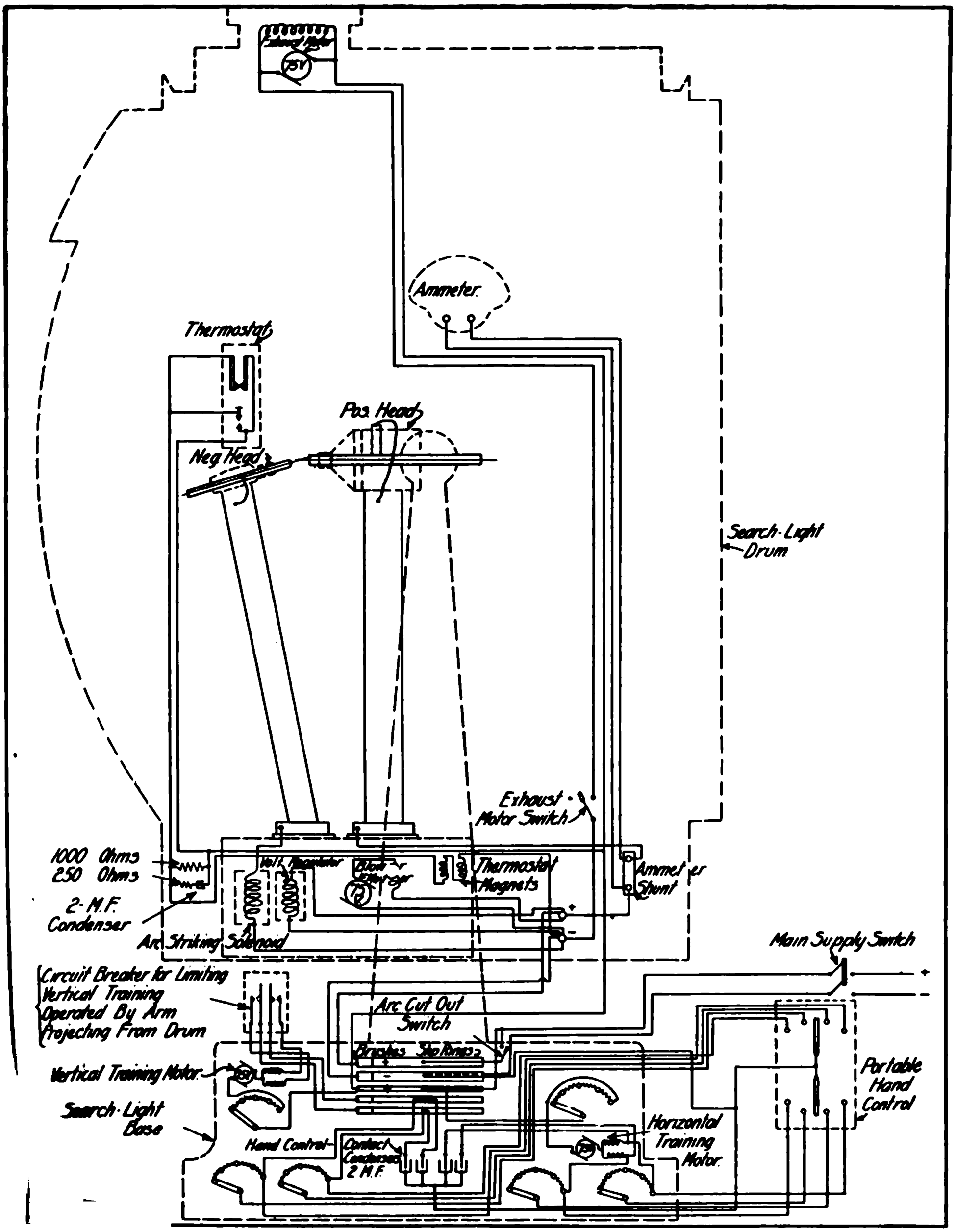


FIG. 5.

WIRING DIAGRAM OF THE SPERRY SEARCHLIGHT

2824

The positive carbon is rotated, being connected to the motor (10) through a vertical shaft (5) and a worm gear. A small crank carrying a crown gear, which engages a gear on the vertical shaft is used to rotate the carbon by hand if necessary.

The positive feed is operated by thermostatic control of the solenoids (8) through the vertical shaft (6). The thermostat is mounted on the drum and so arranged that when the positive carbon burns out of the focal point of the mirror the light from its crater is brought on to the thermostat, causing feed of the positive carbon until the focal point is again reached. This automatic control of positive carbon is also supplemented by hand control.

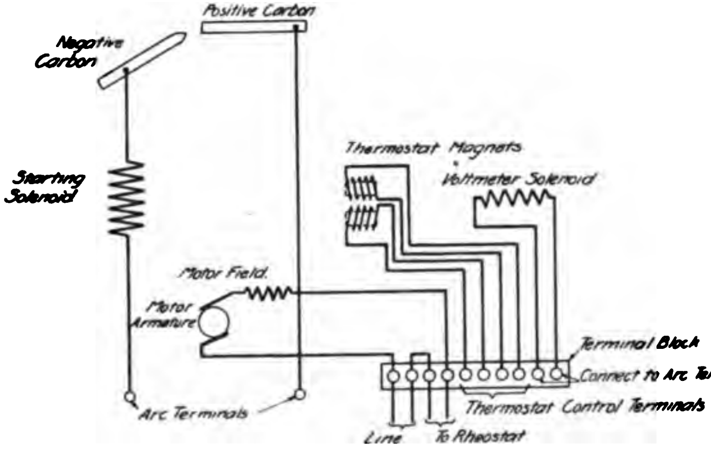


FIG. 6. 1835

ABBREVIATED WIRING DIAGRAM OF THE SPERRY SEARCHLIGHT LAMP

The feed of the negative carbon is controlled by the solenoid (12) connected directly across the arc and moves the carbon in the proper direction as the voltage rises or falls. The automatic feed of the negative carbon is also supplemented by hand control. A striking solenoid (21) moves the entire negative holder back the proper arc length on striking of the arc.

The entire negative carriage can be turned to the right to permit new negative carbons to be inserted; when so turned, the grip on the carbon is released slightly permitting a new carbon to be slipped in easily.

The operation of the Sperry lamp is very steady and requires but very little attention after the simple adjustments for length of the arc, speed of rotation of the positive carbon, and the feeding of the carbons have been made. The positive carbon is inserted into the holder by slowly rotating it and pushing it forward at the same time. The negative carbon can be easily put into place when the carriage is swung to one side.

A rheostat is used in series with the arc adjusted so as to get a voltage across the arc of about 75 volts.

The hand control is shown in Fig. 5. This mechanism consists of a small pointer with a handle 6 inches in length mounted above the operating mechanism, which is contained in a small brass composition box of overall dimensions of about 3 inches wide by 3 inches high and 5 inches long with a total weight of about 7 pounds.

In operation of the hand controller, the pointer is kept in the direction to which the beam of the searchlight is to be trained. The vertical and the horizontal training motors are series wound and both have the same system of speed control. By means of a double contact arrangement, two speeds are provided for each motor: On the first, or slow speed contact, resistance is placed in series with the motor armature; on the second, or high speed contact, all the resistance is cut out. The second or high speed is about three times the first or slow speed.

This controller is connected by an interior communication cable to the operating mechanism at the base of the searchlight, by means of which the drum is turned in azimuth or elevated or depressed, corresponding to the movement of the controller handle at the distant station.

A very important advance in this work has been in the manufacture in this country of carbons suitable for such searchlight arcs. Formerly the only source of supply of carbons suitable for these results was Germany, but after many months of co-operative work between the largest carbon manufacturers of this country and the Sperry Company, the latter is now able to manufacture superior carbons for this purpose.

The Sperry Gyroscope Company, which has developed this arc, is now using it in searchlights of 24-, 30-, 36-, and 60-inch diameter. In addition, the Sperry lamps are being installed in old searchlights replacing the old form of arc.

GIVE ALL BASE LINES TO THE FIRE COMMANDERS

By Colonel HENRY C. DAVIS, Coast Artillery Corps

In the present division of work and responsibility under our Fire Control System, the F.C.* has a base line or he is supposed to have one with all the accompaniments. The B.C.* has under his orders at least one base line and accessories for his battery. The latter may need more than one under certain local conditions and under certain emergencies. The local conditions exist when the water area covered by the gun cannot be efficiently covered by one base line. This may arise from the cutting off of the view by material objects, or from the obliquity of the base line to the direction of observation giving angles approaching 0° and 180°. In some localities neither of these condition exists and hence, so far as local requirements are concerned, one base line per battery is sufficient. The demand for more than one base line under emergencies, however, is not restricted in any way. Some cases may be less urgent than others due to inconspicuousness of stations, better protection for some, or greater perfection in the installation. All, however, to a greater or less degree, show liability to break down due to injury from fire or failure in installation.

These remarks refer primarily to the horizontal bases but are very largely applicable to the vertical systems. The horizontal system being the typical one, attention is addressed to it leaving the application to the vertical system only when it applies.

Local conditions at two important commands known personally to me are illustrations:

1. In the first, a practically all-round fire is imperative for the two mortar batteries comprising one Fire Command. These batteries are about eight hundred yards apart and separated by high ground. No satisfactory horizontal base line could be provided and no one point of observation for the

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* F.C. Fire Commander. B.C. Battery Commander.

whole area was available. To cover all the area that the mortars could reach, there were installed six D.P.F's.* As both batteries could reach practically all the areas, it was necessary to duplicate the D.P.F's; or to be prepared to make the whole Fire Command into one battery, directed by one D.P.F., when occasion demanded.

The solution was to put any one of the six D.P.F's at the disposal of either battery. This solution may not be the ideal one but seems the best under conditions where the mortar batteries might be required for different fields at the same time.

2. In the second case, the fire is also nearly all-round: the two mortar batteries, as before, covering the whole field; and the guns divided, some covering one field and some another with overlaps. The difficulty at this last mentioned fort lay in the necessity for base lines of widely differing azimuths.

The same problem arose in the last case that was found in the first, viz., the system must be largely duplicated or the installations must be more or less common property for the several batteries.

To these cases I desire to draw special attention and to ask that they be kept in mind when considering what follows. These are not hypothetical cases and, although no names are mentioned, I think the localities are recognizable.

It seems perfectly safe to estimate that each battery, as a rule, will need more than one base line to efficiently cover its field of fire and, when the difficulty in getting at least one is considered, there is a real demand for any system that can economize in fulfilling the requirements. When we add the requirements necessary for emergency, the demand is more pressing.

Leaving this feature for a moment, let us take up another detail of the Fire Control system. Having been assigned to targets for his command, the F.C. proceeds to study the conditions and to make assignments to the batteries of his command. The *Coast Artillery Drill Regulations* assume that he may have to track targets, not easily designated by description, for which he uses the F.C. base line. Now suppose that he is able to use one of the base lines normally used by a battery and then assign that base line with the target being tracked it to the battery, he is assured that the observers are both e desired target and that the B.C. will get on the proper

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D.P.F's Depression Position Finders.

one by getting data from his plotting room. The problem seems simplified in that the danger of error, if not of the time lost in the B.C. recognizing the target and getting both observers on it, is eliminated. His co-ordination of the guns with the plotting room does not differ in the two cases.

Some of the details of this operation will be taken up later, but for the present let us assume that they are satisfactory and see what is the result. No more lines are needed than in the case where each battery has its own line and the F.C. has his. Take, however, the average case or one of the extreme ones noted at the beginning of this paper, remembering that each battery will probably require at least two lines to properly cover its area, the advantage is evident. There results a flexibility easily thought out if any one of the base lines is available for any one of the batteries.

If two batteries are put on the same target, not an unusual case, and assigned to the same line, the remaining line may be put on the next target, ready for a "change target" as soon as the occasion arrives and that with a minimum loss of time and with the avoidance of confusion threatened in getting everybody on the new target in the excitement of firing. Again, the F.C. could put his two batteries on different areas if conditions called therefor *even though he had but one line covering each area* and could swing one battery to the target of the other by putting both on the same base line.

If there is a full installation so that each battery has its own base line for each area, the necessity for this arrangement is not pressing as long as things remain normal. Where, however, is there such an installation or when will there be? If all lines are available for each battery and for the F.C., the individual line for the latter might be eliminated and the total number for all purposes reduced.

So much for normal conditions. Let us now consider *emergency conditions.* The station of one of the battery's base line is destroyed, or for any reason fails. What can the B.C. do? He has no other base line covering the area and must resort to his emergency system. What this ought to be, we know; and we also know what it really is; and for some time, what it really will be. I am not opposed to the emergency system, but believe it should, as the name implies, be only a very last resort. If all lines are available for all batteries, the solution is simple: Put the battery with the disabled line on some other available line—whether there is such a line, is best

ADDITIONAL PRACTICES IN THE COAST DEFENSES OF PENSACOLA

FROM A REPORT RENDERED BY LIEUT.-COL. WILLIAM C. DAVIS,
COAST ARTILLERY CORPS

In the additional practices in the Coast Defenses of Pensacola, there were two features which were novel and which probably would be of interest to all Coast Artillery officers. The first was the target practice of the 20th and 22nd Companies, Coast Artillery Corps, at Battery Worth, 12-inch B.L.M., commanded by Capt. J. E. Wyke, C. A. C. The allowance for this practice was six cast-iron shot (1046 lbs.) and ten 1000-lb. torpedo shell filled with 122 pounds of trotol each.

FIRST FEATURE

DESCRIPTION OF TARGET

The target consisted of a sand-bag revetted infantry firing trench (about one hundred feet in length), a communicating trench, and a splinter proof cover trench, made of drift wood picked up on the beach. Also some shallow detached pits for infantry support and dummy field howitzers as shown in Fig. 1. They were located on Santa Rosa Island, some three miles east of the firing battery, and were intended to represent hasty works such as an enemy landing on the island might quickly throw up for his protection. The firing trench was located on a sand dune of some fifteen to eighteen feet above mean low water, and was traced about perpendicularly to the shore line; it was well screened from front view by brush wood, which also would have offered considerable of an obstacle to an attacking party. The cover trench was located on lower ground, three to four feet above mean low water, and some three feet of sand piled on the planking rendered it proof to small arm missiles and shell fragments.

The trenches were completed under direction of First Lieut. H. A. McCune several days before the firing, and con-

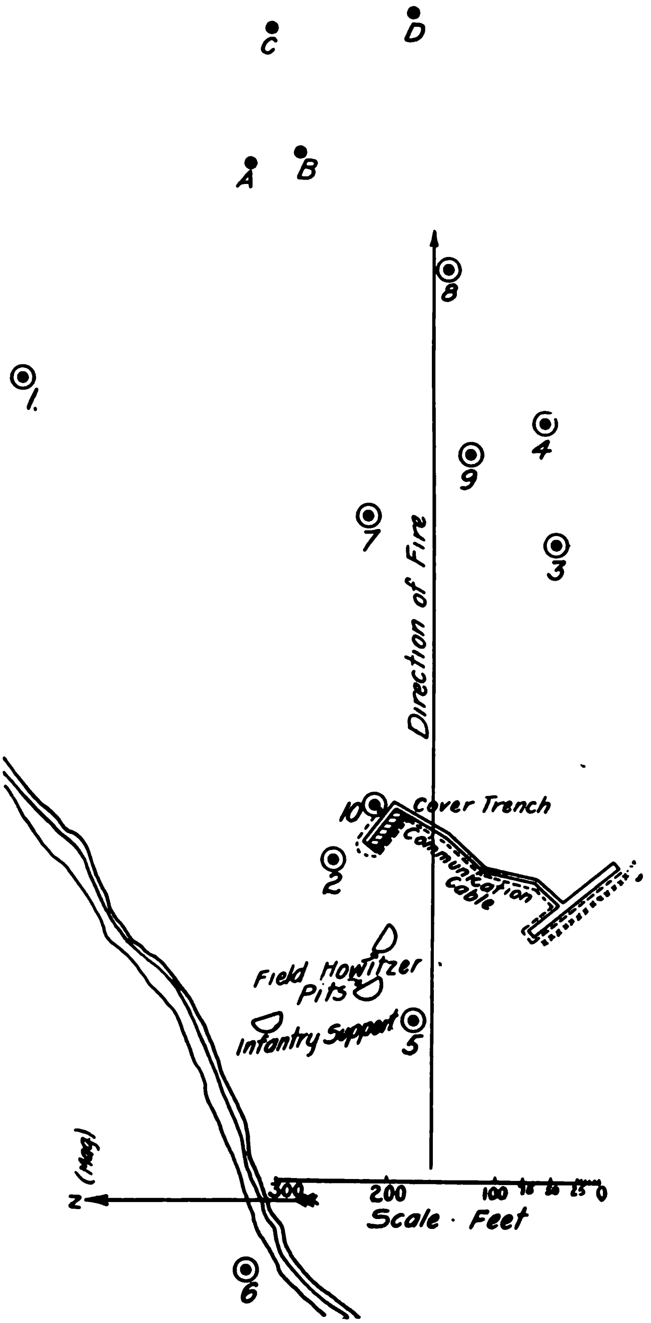

Fig. 1. 1836

Plot Showing Results of Land Firing

C. I. TRIAL SHOTS, WT. 1046 LBS., A, B, C, D. TORPEDO SHELLS, WT. 1000 LBS., NO. 1-10.

siderable sand had blown into the firing and communicating trenches. On account of a bend in Santa Rosa Island, the line of fire from the mortars was at an angle of about 45 degrees to the normal of the firing trench.

METHOD OF DETERMINING RANGES, ETC.

The battery commander had only general information as to location of the target. It was sufficient, however, to determine the proper zone for his powder charges. Neither he nor any of his officers or men had seen the target site prior to firing, and he had only such general information concerning same as was furnished him by the naval aviator's reconnaissance before the practice. As the firing was at a target nearly due east of the battery and in prolongation of the base line, an auxiliary base end station was established on the Naval Reservation, which, with the B″ or B.C. station, gave a favorably located pair of auxiliary base lines. The trenches, however, were not directly visible from any of the battery stations.

Through the courtesy of the Commandant, Navy Aeronautic Station, Lieut. (J. G.) R. C. Saufley, U. S. N., was detailed to co-operate with the Coast Defenses during this year's target practice. His machine during this practice was equipped with a signal apparatus for producing smoke puffs by burning oil in the exhausts. In determinging the range to the target, the aviator directed his flight over the cover trench, and shortly before reaching same let out a continuous stream of smoke, cutting it off when directly over the trench. The observers, who were following the airplane, read azimuths on this signal which was easily observed. Several observations were made for the location of the target, which was plotted on an improvised board in the battery plotting room.

SIGNALS USED FOR INDICATING SHORTS, OVERS, ETC.

Smoke signals from exhaust, with International Morse Code, were used. The longitudinal deviations were first indicated, then the lateral deviations; these being repeated a number of times. "O," over; "S," short; "R," right; "L," left. A long dash ("T") indicated a hit. The amount of deviation was indicated by a numeral (indicating hundreds of yards) immediately following the letter. A 50 yard increment was indicated by appending the letter "A" after the numeral. For example:

O 5; L 1 A	Over 500 yards; left 150 yards.
S A; R 2	Short 50 yards; right 200 yards.
T	Hit.

These signals were all clear cut, and there was no difficulty in reading them whatever, except when the airplane happened to be projected against a cloud as background. In that case there was but little contrast between the grayish smoke and the cloud, and the signals were obscure. By repeating the signals several times, however, while the plane was maneuvering, it was usually possible to decipher them correctly, even when the background was not favorable.

The following table shows the longitudinal and lateral deviations as observed from the aeroplane, as received by the battery commander from the aeroplane, and as actually measured on the ground:

Longitudinal Deviations

	Observed	Signal received by Battery Commander	Measured
1	+150	+100	+128
2	Hit	Hit	− 17
3	+ 50	+100	+ 80
4	+100	+100	+115
5	− 50	− 50	− 65
6	−200	−200	−142
7	+150	+100	+ 88
8	+200	+200	+160
9	+150	+150	+106
10	Hit	Hit	0

Lateral Deviations

	Observed	Signal received by Battery Commander	Measured
1	0	L 150	L 110
2	0	Hit	L 20
3	R 50	R 50	R 45
4	0	0	R 42
5	0	0	L 5
6	L 50	L 50	L 48
7	R 50	R 50	L 11
8	0	0	R 14
9	0	R 100	R 21
10	0	0	L 8

During the practice Lieutenant Saufley maneuvered with his machine about a mile to the west of the target until he saw the flash, when he steered over the target arriving in ample time to observe the fall.

The system of signaling used by Lieutenant Saufley gives quickly and positively all the desired information; a radio set might supplement it, but as the radio might be "jammed" by an enemy, I believe the smoke system of signals preferable. It remains to perfect a blacker puff to render the system perfect. Further experiments in this important matter are being conducted by Lieutenant Saufley.

RESULTS OF FIRE

No difficulties were encountered at the firing battery, except two missfires due to faulty wiring. The detachments took cover, however, before each shot was fired.

No satisfactory observation of the point of impact of the cast iron trial shots fired on the land was possible. They simply disappeared in the rather marshy ground in which they happened to fall, without appreciably disturbing the earth. They were all afterwards located, as shown in Fig. 1, and were found to have made a crater about seven feet deep and two feet in diameter, in each case. On the other hand, the trotol shell all functioned beautifully, sending up a large pillar of dense black smoke very easily observed.

The craters made by the high explosive shell were all quite similar, being nearly circular, about twenty feet in diameter, and from four to five feet in depth. The fragmentation appeared to be very good and uniform, spreading out in all directions from the crater, but especially forward of same, several hundred yards. No large pieces were recovered, but fragments were reported by the guard as passing beyond their post, some twenty-five hundred yards east of the target, while other fragments were observed to strike into the water at least one thousand yards on the flank of the crater. The aviators reported some fragments rising apparently eight hundred to one thousand feet in the air.

Only two of the torpedo shell fell close to the main works—No. 2 and No. 10. A length of single conductor submarine cable (condemned cable) was stretched from the firing trench alongside of and in the communicating trench, being finally led into the cover trench, as shown in illustration. Silhouette targets were placed in the trenches at about three yards intervals, and two dogs were tied in the northwest end of the cover trench, some thirty feet from the center of No. 10 crater, and about forty feet from the center of No. 2. The cable was cut in three or four places apparently by fragments from No. 2; two of the silhouettes in the communicating trench were wounded—one in the neck, one in the shoulder; twenty feet of the cover trench nearest No. 10 crater was completely demolished; and about ten hits in the other section of the cover trench were counted, one fragment partially cutting the rope by which one dog was tied. But the two dogs were uninjured, their hearing unimpaired. They were adopted by a soldier, and are apparently not at all the worse for their close experience with torpedo shell. Several fragments were picked up in the field howitzer pits, without injury to the dummy guns.

CONCLUSIONS

From the experimental firing above described, which was exceedingly interesting and instructive to all witnessing it, the following conclusions appear to be justified.

a. The necessity for an aviation section to be attached to every important Coast Defense, in order to secure early information of the enemy's ships and possible attempts at landing, to prevent enemy's aerial reconnaissance of our Coast Defenses, and to locate and direct fire of seacoast cannon on land targets. The practicability of the last named feature of usefulness of the airplane cannot be doubted by anyone who witnessed Lieutenant Saufley's work.

b. The detonation of a 12-inch torpedo shell would probably result fatally to all personnel within fifteen feet of the point of impact, from shock alone; beyond about this radius casualties would probably only be such as would result from shell fragments, and with personnel sheltered by trenches these would be few. Against matériel, this shell appears to exert little destructive effect unless the point of impact is within ten or twelve feet thereof; in such case all ordinary overhead cover and splinter-proof protection would probably be demolished. Therefore, the effective use of this shell against field works would require (1) a large allowance of ammunition; (2) effective system for observation of fire—a condition in a thick country only obtainable by use of air-craft. Under these two conditions there can be no doubt of the effectiveness of this weapon on a land target; but the number of rounds to be fired to accomplish definite results will be much greater than most of us have hitherto thought necessary.

c. As a practical coast artillery problem, great interest in its solution was manifested by all concerned. It made an agreeable change in the former routine methods of target practice, and the results obtained are believed to justify further work another season along similar lines in those coast defense commands where such work can safely be undertaken.

SECOND FEATURE

The second feature of the additional practices, which was unusual, was the test of readiness at Battery Payne, 3-inch B.L.R., which was manned by a portion of the 163rd Company, Coast Artillery Corps, by Second Lieutenant John H. Jouett, C. A. C. In this practice, the company made six hits out of twenty shots. The following extract from the coast defense commander's indorsement describes the manner in which the test was held:

> This practice was carried out in accordance with the recommendations contained in approved Report of Board of Officers, as follows, except, as there was only one lieutenant on duty with the Company at the date of firing, but one "Test of Readiness" practice was held, in which all four gun-sections were employed:
>
> EXTRACT FROM BOARD'S REPORT
>
> "b. Two tests for readiness practices of two strings each, to be held on separate days during the remainder of the service practice period.
> Ten minutes to be allowed for breaking out ammunition.
> Battery Commander's Action.
> Orders to be transmitted through Mine Commander.
> Senior Lieut. and 1st Relief to fire First Practice; and
> Junior Lieut. and 2nd Relief to fire Second Practice."

In carrying out this program, on the night preceding this practice, the "fleet," consisting of the *Swartwout*, the *Poe*, and *D. B. Boat No. 11*, went out about 10:00 P. M. for night maneuvers; after completion of night phase remaining out for the night. The *Poe* going out took a rapid fire target alongside, unnoticed by the battery (Payne). Just at daybreak the *Poe* started in, letting out its target and tow-line in rear of a large tramp steamer anchored about six thousand yards from the battery, near the whistling buoy. The *Swartwout* at same time started out, simulating a bombardment. This was at 5:21 A. M. There was a heavy haze, like steam, close to the water, making it difficult to see the towed target from Battery Payne, which is low cited. At 5:30 the field of fire was reported clear, "call to arms" was sounded, and the target was assigned to the Mine Commander, who gave Battery Commander's

Action. The Company, except a watching detail, was in camp, in bed, having been turned in from the night phase, and had some three hundred yards to go to reach the battery. The ammunition was promptly broken out, and first shot was fired at 5:41.

This exercise more nearly approached a real "test of readiness" than has been seen before, and was a valuable experience for the command generally.

In bringing his report to a close, Colonel Davis recommended that the War Department tender through the Navy Department its appreciation of the cordial co-operation and splendid work done by the Navy Aeronautic School throughout this year's target practice in these Defenses; particular thanks being extended to Lieut.-Com. H. C. Mustin, Commandant of the Station, and to Lieut. (J. G.) R. C. Saufley, the aviator conducting the flying, who always promptly responded whenever his services were needed, and pluckily stuck to his work through the long periods sometimes necessitated by the practice.

PLANTING AND RAISING MINES FROM SCOW

BY CAPTAIN ERNEST A. GREENOUGH, COAST ARTILLERY CORPS

As the Mine Planter, *Major Samuel Ringgold*, was not available for service in planting mines in 1913 with the 150th Co., C. A. C., I patched up an old scow found abandoned on the beach near Fort Worden and with it that Summer planted the mines for the Company Mine Practice. This old scow finally sank at Fort Ward and was beyond repair.

In the Fall of 1914, at my recommendation, a new scow was built for emergency mine work at Fort Ward and as the planter was not available during the 1915 season, the scow was used instead. This new scow is 18 feet wide, 45 feet long, and 5 feet deep, well built with three longitudinal bulk heads, 6-inch sides, 5-inch bulk heads, 5-inch bottom, and 4-inch deck, and cost $750.00. It will easily carry all the material for a group of seven mines.

The multiple cable (one mile, seven conductor) was laid from the scow, the reels set up on cable reel jacks on deck and the scow towed alongside the Harbor Boat *Lieut. J. A. Gurney*. When the end of the first reel of the cable was reached, it was passed to the D. B. Boat with the outer end of the second reel and the laying of cable continued to the end where it was buoyed. The D. B. Boat connected the two cables through a junction box, let it go with a buoy attached and went to the outer end, pulled up the cable, tested it through to the casemate, and put on the distribution box. The multiple cable was laid quite as quickly and in just as good position in all respects as had been done with the planter.

For mine practice, September 15, 1915, five loaded mines, two empty mine cases, five single conductor cables, seven mooring ropes, seven anchors, seven buoys, seven buoy ropes, heaving lines, and the necessary tools were loaded onto the scow. The detachment on board the scow consisted of the Chief Planter and eight men—two for making joints, two for handling the mines after making the joints, two for handling the anchors, and two or handling the cable and paying it out.

In coiling the cable into a figure of eight, the raising rope was laid beside the cable and coiled with it, being seized lightly with yarn at convenient intervals to keep the coils of the cable and raising rope together but not so strongly that the seizing would not break easily. The end of the raising rope first to come aboard, in taking up, was made fast to the cable in the usual manner. The cables were piled about the middle of the scow; the anchors lay conveniently on the forward end of the scow, four on the starboard side and three on the port side. The mine cases were laid on the rear end of the scow as towed: numbers 7, 8, 9, and 10 convenient to the starboard side; and 11, 12, and 13 convenient to the port side; with the coiled mooring ropes and the keg buoys properly numbered, and convenient to the mines.

The scow was lashed securely along the starboard side of the "*Gurney*" which started for the mine field. On the way out, the cable for the No. 10 mine was lifted from the pile of cable and laid near the starboard side of the scow, lashings cut, the mine end taken to the mine where the joint was made, and the anchor end of the raising rope taken forward and made fast to the anchor. The anchor had been rolled onto the end of a plank and near the edge of the scow. The mooring rope was fastened to the mine and anchor, the coil lying forward of the cable. When the mine joint was made in the cable, and the buoy rope passed through the ring and made fast to the keg, the mine was rolled to the edge of the scow and all lines and the cable layed to go overboard outside the towing bitts of the scow.

As the scow, towed by the "*Gurney*," passed the D. B. Boat, the end of the cable was passed to her by a heaving line and the cable sent overboard, coil by coil, by the men assigned to that duty. When the cable was passed out, the command "Let go" was given; the mine was rolled over; the two men handling the anchor lifted the inner end of the plank and the anchor was slid overboard after the mine. Loaded mines 8 and 9 were planted from the starboard side of the scow the same as number 10, and the empty mine case to correspond to number 7 was planted on the line of mines without the single conductor cable. This mine was calculated to have the same submergence as the loaded mines and to carry the buoy marking that end of the mine field. As this mine had no cable from the D. B. Boat, the raising rope was lightly seized with marlin about thirty feet from its end to

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scow, so it can be detached and put out of the way; and also to set up one davit of the emergency planting gear, fastened to one of the bitts near the cathead. A one thousand pound anchor can then be raised overhand by ten men and swung aboard by the davit.

In time of war, when it is desired to plant mines in all the harbors at the same time and no planter available, a scow of suitable size and a boat to tow her could be requisitioned in any harbor and the mines planted almost as quickly as if a planter were available. Any boat suitable for towing such a scow would probably have a steam windlass by which the mines could be raised for repair.

IMPROVISED PERISCOPE FOR USE IN PLOTTING ROOMS NOT CONNECTED WITH AN OBSERVING STATION

By Major HAROLD E. CLOKE, Coast Artillery Corps

The device herewith shown was constructed at this post (Fort Flagler) with the material on hand and by post labor. Since using it in the plotting room, it has been found of immense benefit to the plotter in keeping him informed as to the course of the target.

The range officer could operate it and observe the course of the target through field glasses. Any slight change in the target's course can be readily observed and the plotter can be immediately informed so that his next prediction will be more liable to fall on the "prolongation line" of the course.

This is the essential principle of reliable predicting in vessel tracking and it was thought that when this device was designed, though old in principle, it was particularly adapted for this use in the plotting room.

For example, it has been found that many errors in predicting have been caused by a change in the course of the target, such a change being entirely unknown to the plotter and there being no way for him to know the same except through information furnished him by observers. The error of predicting on a line in prolongation of previous plottings will be greatly reduced if the time interval be reduced. With the thirty-second interval, however, or even a twenty-second interval, appreciable errors occur in finding the predicted point when the target is going at high speed and frequently changing course. The periscope idea was suggested in preference to the message relay method from observer to plotter on account of its *simplicity* and *directness* of application, and avoidance of message relays through telephones.

The persicope operator should use field glasses in case it is non-telescopic (such as shown in this design), and when he observes the target changing course he would inform the plotter accordingly. For example, "Target changing course about ten degrees toward datum point 6."

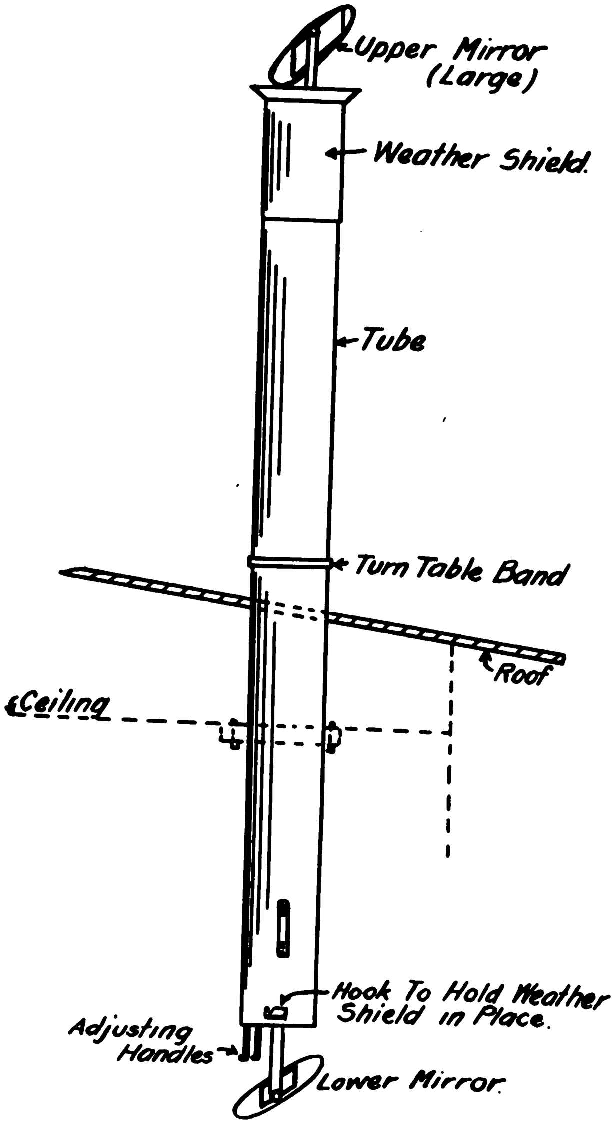

FIG. 1.

1837

This, to be sure, is not a *mathematically accurate method* but the periscope is a good, reliable, *practical* instrument and one easily constructed for any battery at any post.

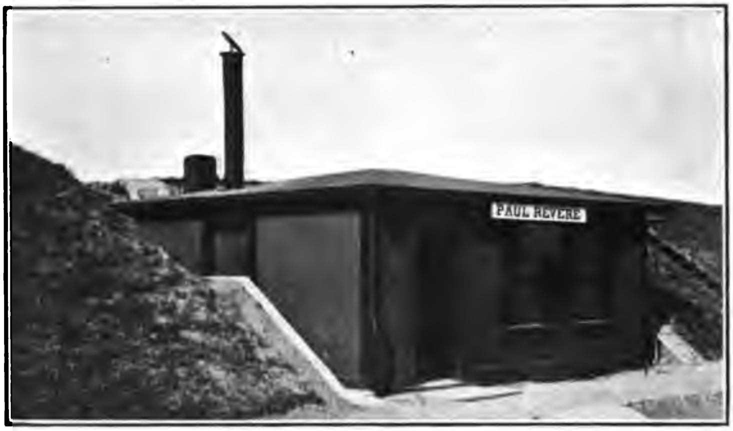

FIG. 2. 1838

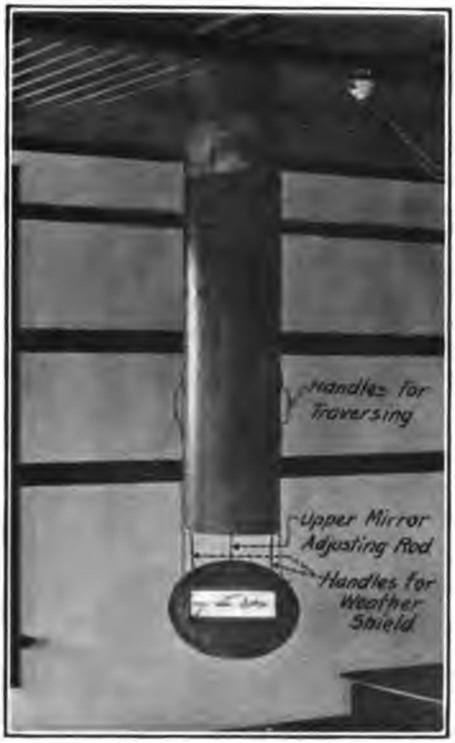

FIG. 3. 1839

In addition to the above use, the periscope in the plotting room permits of a good view of the effect of fire and, at the same time, the officer in charge can see the whole field of view—even the men at the guns, if the guns be in front.

The cost of such a device is very small. The tubing is of ordinary ventilator piping, about 12 inches in diameter. The mirrors are plate glass. The height depends upon the depth of the plotting room below the parapet. The whole instrument can be constructed by post labor, and the roof fitting done by Engineer Department employees.

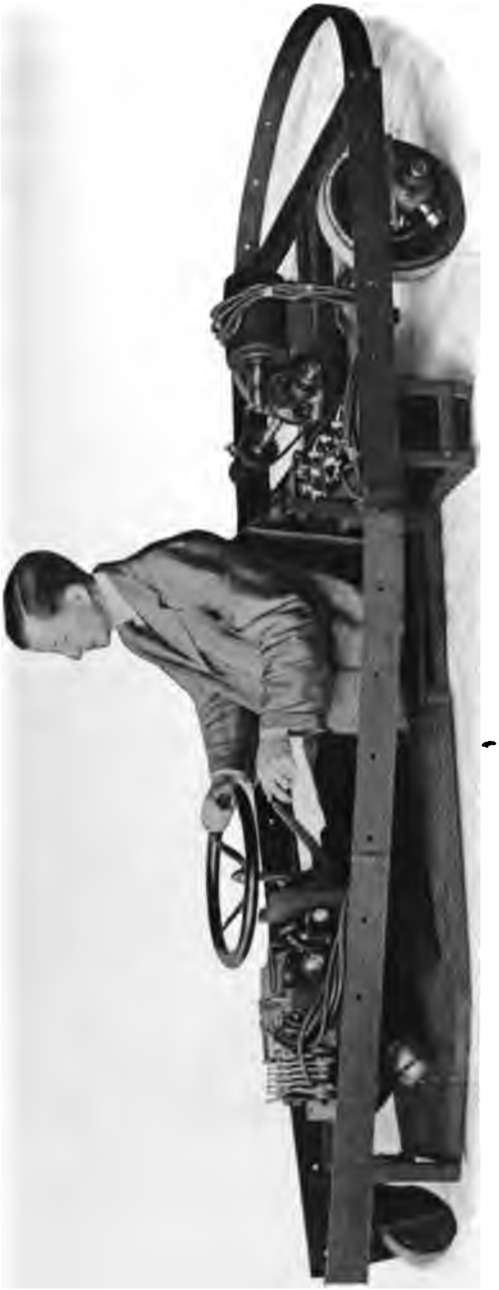

FIG. 2.

1841

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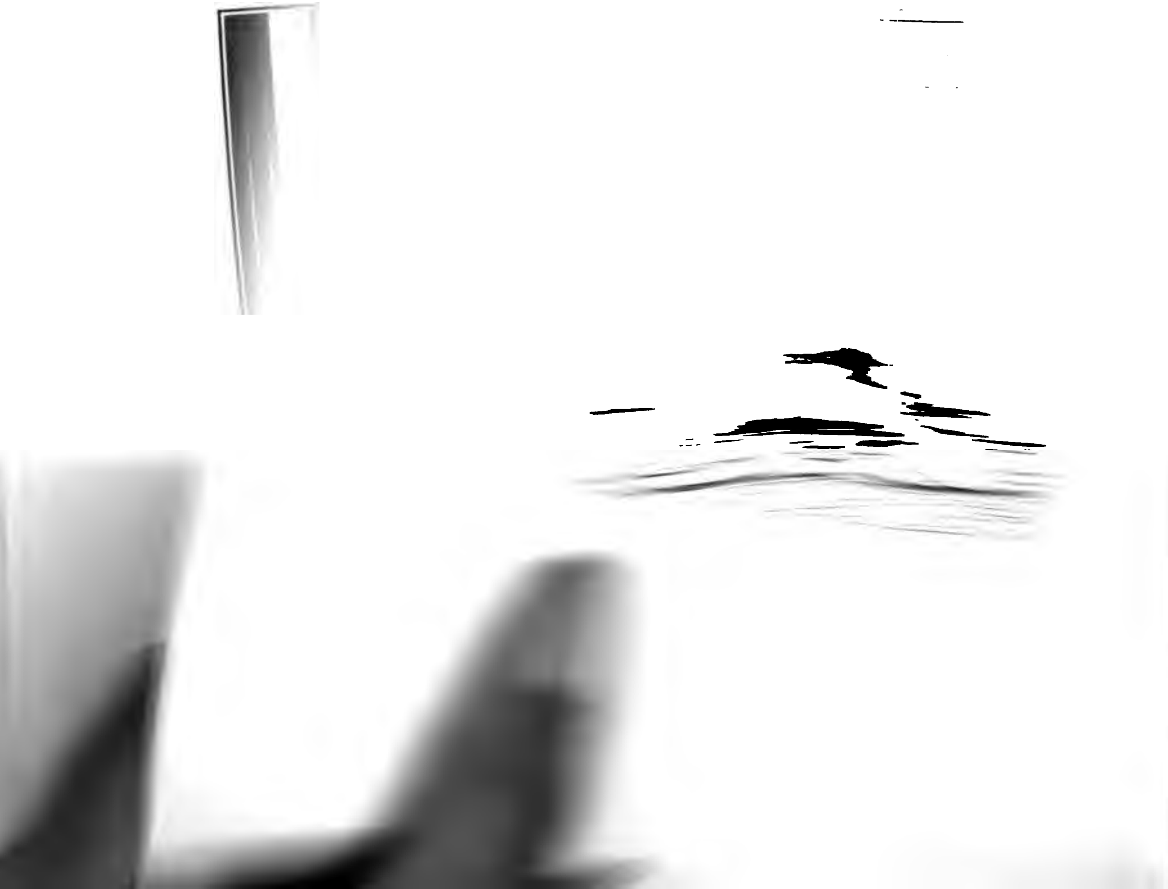

PROFESSIONAL NOTES

THE CO-ORDINATION OF THE MOBILE AND COAST ARTILLERY UNITS OF THE ARMY IN THE NATIONAL DEFENSE

ared by the War College Division, General Staff Corps, as a Supplement
o the Statement of a Proper Military Policy for the United States

INTRODUCTION

RELATION BETWEEN STATECRAFT AND WAR

In our country public opinion estimates the situation, statecraft shapes e policy, while the duty of executing it devolves upon the military and aval departments. In settling disputes under our foreign policies, the eapons of our statesmen are, first, diplomacy and, second, war; when iplomacy fails to settle the matter in dispute, it may be necessary to resort to war. Should such a contingency arise, we must be prepared to meet the enemy on sea and land. This preparation should be adequate at all times or else our national policies will be aborted or frustrated. Such preparation includes as its most vital element the development of our land and sea forces.

DEFENSE AGAINST OVER-SEA INVASION

The object of this study is to treat primarily of operations which will come in one way or another from the sea and to which we are most vulnerable. Consideration is therefore limited to operations possible along our seacoast, and an attempt is made to show clearly the correlative functions of the Army and the Navy and the resultant necessity of the co-operation of the *mobile* and *coast artillery* units of our land forces so as to best utilize our means of defense, in conjunction with our Navy.

FUNCTION OF THE NAVY

Upon the Navy devolves the solution of the problem of securing and maintaining control of the sea. To accomplish this it must be free to take the offensive promptly, that is, to seek out and defeat the enemy fleet. The use of any part of the high-sea fleet for local defense defeats the chief object of the Navy, and is a misuse of naval power. A fleet defeated at sea and undefended by an adequate army is powerless either to prevent invasion or even its own ultimate destruction by combined hostile land and naval forces.

FUNCTION OF THE ARMY

Upon the Army devolves the task of gaining and maintaining on shore the ascendency over hostile land and naval operations. To accomplish this it must be able to seek out promptly and to defeat, capture, or destroy the invader wherever he may attempt either to secure a footing upon our territory or to enter the waters of our harbors with the object of threatening the destruction of the seaport or of a fleet driven to seek refuge or repair therein.

FUNCTION OF THE MOBILE AND COAST ARTILLERY TROOPS

TWO CLASSES OF TROOPS REQUIRED

Experience has shown that our Army must consist of two distinct classes of troops—that is, *mobile troops* and *coast artillery troops.* Broadly speaking, the principal function of our mobile troops is to oppose an *invading army*, while that of our coast artillery is to oppose *direct naval attacks.*

MOBILE TROOPS

The best defense can be accomplished only by the ability to resort to offensive operations. Our mobile troops are organized on the basis of being able to resort to offensive as well as defensive operations. Some of the functions of the mobile troops are:

(*a*) To furnish detachments of mobile forces sufficient for the protection of harbor defenses and naval bases against landing parties during naval raids which, under modern conditions, may precede a declaration of war.

(b) To oppose an invading army and to operate in any possible theater of war.

(*c*) To furnish adequate mobile forces to protect our principal cities by preventing the landing of hostile expeditions for their capture in the intervals between our fortified harbors or near such cities.

The only reasonable way in which these localities not covered by fixed defenses can be defended is:

(1) By providing a mobile land force of sufficient strength, so located that it may be thrown in at threatened points at the proper time.

(2) By supplying in addition modern movable coast defense armament of heavy types to resist the direct naval attack of the covering fleet.

COAST ARTILLERY

Our coast artillery is primarily organized for defensive operations. Some of its functions are:

(*a*) To prevent naval occupation of important strategic and commercial harbors.

(*b*) To prevent naval bombardment of such cities and military and naval bases as are protected by seacoast fortifications.

(*c*) To furnish a strong, fortified base from which submarines and other naval vessels, acting on the offensive, may operate.

(*d*) To repel a fleet supporting a landing in force within range of the guns of a fortified harbor.

(*e*) To co-operate with the mobile troops in the landward defense of seacoast fortifications.

With the development of modern movable artillery of large caliber and long range, the functions of the coast artillery will be extended to repelling direct naval attack at certain unfortified harbors and favorable landing beaches in the intervals between the present fortified harbors, under the commanders of the mobile forces.

MUTUAL DEPENDENCE OF MOBILE AND COAST ARTILLERY TROOPS

CO-OPERATION OF MOBILE AND COAST ARTILLERY UNITS

While our Navy retains command of the sea, the only invasion possible would come from raiding parties, limited in numbers, which an enemy fleet might land. In addition, therefore, to the coast artillery troops required to man the emplaced batteries and the mine defense of our fortified harbors, sufficient mobile troops should be provided to repel local raiding parties that might land to attack the fortifications. The personnel of the Army assigned to the fixed-gun defense, the mine defense, and the land defense in the immediate vicinity of the fortifications, may be classed while on this duty as immobile to the extent that their duties are local and pertain particularly to the harbors to which they are assigned. Thus it is manifest that a portion of our mobile troops must be used at times as fortress troops, while the development of modern high-power movable coast-defense armament of heavy types will render a portion of our coast artillery troops more or less mobile.

Should our Navy lose command of the sea, the fleet will seek refuge in our fortified harbors, under the protection of their guns. Here they may repair and refit, and they may be able to render valuable assistance in opposing the landing of an invading army. Assuming that our preparations are sufficient to prevent the enemy fleet from capturing the armament of our fortified harbors, running by the forts, or from resorting to distant bombardment of the cities thereon, he will be forced to attempt any landing (his only other means of inflicting damage) in the intervals between the fortified harbors. This effort can be frustrated only by *adequate* mobile forces held at strategic centers near the coast and rushed to the threatened points at the proper time. This force should be sufficient in numbers, training, armament, and equipment to accomplish its purpose.

In defending the intervals between our fortified harbors, the movable coast artillery becomes one of the auxiliary elements of the mobile force; mutual dependence of the two kinds of troops along our coast-line and frontier makes their co-operation imperative; movable heavy coast artillery armament renders such co-operation more effective.

LANDINGS AT UNFORTIFIED POINTS

History shows that landings at unfortified points have always been effected when backed up by the fire of a fleet. This is well illustrated in the recent landings on the Gallipoli Peninsula, where the allied fleet, after being defeated in the attempt to run by or reduce the Dardanelles batteries, supported the allied army on Gallipoli and enabled it to land, despite the vigorous defense of the Turkish mobile forces.

ROLE OF MOVABLE COAST ARTILLERY

With the development and employment of large caliber movable coast artillery, it is confidently believed that at points near our coastal railroads the covering fleet may be held off at such a distance as to prevent the use of the secondary batteries in supporting the landing, which is therefore liable to be defeated by the fire of field artillery and small arms before reaching the shore. Thus it is manifest that the development of heavy movable artillery will greatly strengthen our coast defense. This type of ordnance may be concentrated at points under attack, and when no longer required there can be rapidly shifted to other threatened points on the coast, where its effect would be the greater in that it would be in the nature of a surprise to the enemy, thus enabling the coast artillery and heavy field artillery to co-operate with the other mobile troops in the protection of the intervals between the fortified harbors. The development of a heavy type of movable artillery forms another link between the coast and field artillery and between our present coast artillery and mobile troops. Unfortified anchorages and favorable landing beaches near our coastal railroads may be protected against direct naval attack; the enemy fleet may be driven out of range of the coast artillery, and the invading army deprived of the support of the fleet during the landing. The transports will, of course, be compelled to lower their boats out of range of these batteries, and an excellent opportunity will be given to our mobile troops to defeat the invaders before they can set foot on the shore.

DEVELOPMENT OF HEAVY MOVABLE ARMAMENT IN EUROPEAN WAR

All information from the European armies shows that the development and employment of heavy movable artillery is one of the most prominent features of the present European war. It has been successfully employed there in demolishing fortifications and in blasting the enemy out of his trenches. While the general character of roads and bridges in the United States will undoubtedly operate to restrict the use of the large-caliber guns and howitzers in field warfare, there is no question of the feasibility of their employment as movable coast artillery along our coastal railroads. Descriptions given in the newspapers and illustrated periodicals and the moving pictures of war scenes and implements shown at our theaters illustrate how this heavy movable ordnance may be thus employed.

Successful tests have been made with the 12-inch Navy gun mounted on specially constructed railroad car. This gun as mounted has a range of about 13 miles, and fires a projectile weighing about 800 pounds with over 200 pounds bursting charge; it is transported on and fired from its specially designed railroad car. On account of their mobility these guns can be moved rapidly to the menaced points of the coast, be immediately prepared for action, and when threatened by the enemy's superior artillery can retreat or change position in a minimum time. In fact, this uniting of a certain number of pieces of artillery constitutes a mobile fort, powerful and economical. In addition to these heavy gun batteries, heavy howitzers have been similarly mounted on specially constructed railroad trucks, from which they are fired without having to construct platforms to receive them; the trucks are braced before firing to support the shock of discharge.

In line with the above, our Ordnance Department has prepared estimates for a 14-inch gun to be transported on and fired from a specially designed railroad truck. This gun is to have a range of 30,000 yards (17 miles) and to fire a shell weighing 1660 pounds.

The 30.5-centimeter (12-inch) Austrian Skoda mortar is practically our 12-inch seacoast mortar, while the 42-centimeter (16.5-inch) mortar (Krupp) is larger than any now emplaced in our fortifications; it fires a shell weighing about 1800 pounds. Both of these types of mortars are readily transported by railroad, or over exceptionally good roads and bridges by motor tractors. From photographs and descriptions of these mortars and carriages it is apparent that heavy ordnance of this type can be *effectually employed as an adjunct to our seacoast fortifications.*

These developments abroad suggest the tremendous gain the employment of heavy movable artillery will give us in the defense of our coast. In addition to the fixed defense of our fortified harbors, the employment of *heavy movable artillery* will make it possible to defend not only our important strategic fortified harbors and naval bases, but also to repel a hostile fleet supporting a landing in force at points on our coastal railroads. It is understood that the War Department's estimates to Congress will include 14-inch seacoast guns mounted on specially designed railroad trucks, and 16-inch mortars mounted on movable carriages. If these are provided the area of operations of our coast artillery will be materially extended. Certain unfortified anchorages and beaches favorable for landing, as well as the present fortified harbors, may be successfully defended against direct naval attack.

ADEQUATE MOBILE TROOPS NECESSARY

It should be understood, however, that the employment of movable coast artillery is principally against a direct naval attack, as is the employment of fixed guns in our fortified harbors and naval bases. In landing troops for an attack against a fortified harbor an enemy would naturally select a landing place out of range of its guns.

Mobile troops would be necessary to defend and support the heavy guns, whether fixed, as in our fortifications, or movable, as along our railroads.

The employment of heavy artillery alone could not prevent an enterprising enemy from landing troops. Heavy movable ordnance may indeed render valuable assistance to our mobile troops in repelling a landing in force in the *intervals* between our fortified harbors, but trained mobile troops can be successfully opposed only by the employment of trained mobile troops against them. It should be borne in mind that our coast-line consists almost entirely of "intervals." The fortified harbors are few in number and far apart. Even with the addition to our armament of heavy movable artillery along our coastal railways, there would still remain numerous long stretches of our coast-line and anchorages affording facilities for landing operations which could only be opposed by mobile troops acting without the co-operation of the Coast Artillery. The United States should therefore have sufficient trained, organized, and equipped mobile troops to defeat at the coast-line or frontier the army that any over-sea power could bring against us.

LAND DEFENSE OF SEACOAST FORTIFICATIONS

The defense of the fortified harbors on the land side must be in the hands of the mobile troops. From the time of actual investment by the enemy's army it is essential that all of the fixed armament in the seacoast fortifications capable of being used in the land defense be so mounted that it may be fired landward as an adjunct of the Field Artillery as well as seaward against the hostile navy.

Generally speaking, the seacoast mortars (which have all-around fire) are the only parts of the heavy fixed armament now so emplaced that they can be used in the land defense, but at all forts susceptible to land attack, other elements of the fixed armament should be mounted in the future for all-around fire, where practicable, without sacrificing range and adequate protection against naval attack. Such as are susceptible of being mounted on movable carriages should be so mounted, with the largest calibers and longest ranges possible of development for such mounting. To make the fire of the seacoast armament effective against the enemy's land batteries and trenches it is essential that suitable ammunition and fuses be provided, that an effective means of range and position finding be adopted; that accurate maps of the land area within the range of the fixed armament be provided, and that *ample aero equipment* be furnished for reconnaissance work and for correction of fire. The heavy artillery can, by the adoption of these means, use its trained personnel to the best advantage to assist the mobile troops in the defense of the fortifications.

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THE GREAT NORTH SEA BATTLE

TACTICS OF THE ENGAGEMENT AS DESCRIBED BY BRITISH NAVAL OFFICERS

[The only connected and understandable description of the Battle of the North Sea is that given by the Glasgow *Herald* and cabled in full to the New York *Times* of June 6th. It has all the earmarks of being written by one or more naval officers, and it contains many intimate touches, which at once suggest an eyewitness possessed of thorough experience in the handling of ships and fleets. The fact that, if the maneuvers of the various phases of the battle are plotted out they piece together and form a logical sequence of events from the first gun to the escape of the German fleet by night through a gap in the British line, and that the story agrees closely with the Admiralty reports, is strong evidence that, in its main features, the description is substantially correct. We give the account verbatim. The diagrams, which have been drawn in this office, are based strictly upon the facts given in the article.

It should be understood that, in these diagrams, which illustrate the various phases of the engagement, the British ships are shown in full black and the German in outline. EDITOR.]

FIRST PHASE, 3:45 P. M.

"Beatty's battle royal cruisers, consisting of the *Lion*, *Princess Royal*, *Queen Mary*, *Tiger*, *Inflexible*, *Indomitable*, *Invincible*, *Indefatigable*, and *New Zealand*, were on a southeasterly course, followed at about two miles distance by the four 'Queen Elizabeths.'

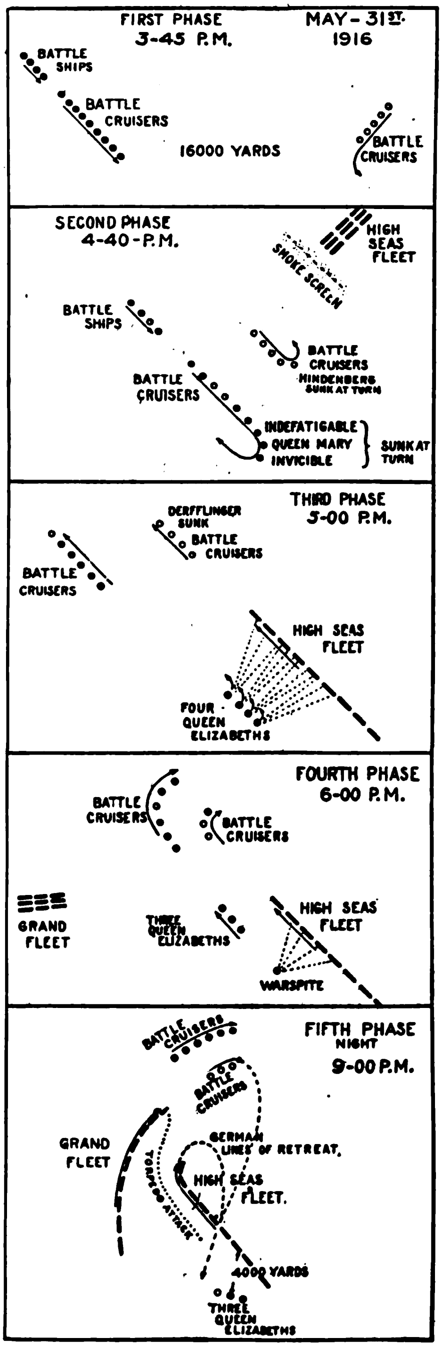
"Enemy light cruisers were sighted and shortly afterwards the head of the German battle cruiser squadron, consisting of the new cruiser *Hindenburg*, the *Seydlitz*, *Derfflinger*, *Lutzow*, *Moltke*, and possibly the *Salamis*.

"Beatty at once began firing at a range of about 20,000 yards (12 miles), which shortened to 16,000 yards (9 miles) as the fleets closed. The Germans could see the British distinctly outlined against the light yellow sky. The Germans, covered by a haze, could be very indistinctly made out by our gunners.

"The 'Queen Elizabeths' opened fire one after another, as they came withing range. The German battle cruisers turned to port and drew away to about 20,000 yards.

SECOND PHASE, 4:40 P. M.

"A destroyer screen then appeared beyond the German battle cruisers. The whole German High Seas Fleet could be seen approaching on the north-eastern horizon in three divisions, coming to the support of their battle cruisers.



Diagrams of Phases of the Fight 1842

"By 5:45 half of the High Seas Fleet had been left out of range, and the 'Queen Elizabeths' were steaming fast to join hands with Jellicoe.

"I must now return to Beatty's battle cruisers. They had succeeded in outflanking the German battle cruisers, which were, therefore, obliged to turn a full right angle to starboard to avoid being headed.

"Heavy fighting was renewed between the opposing battle cruiser squadrons, during which the *Derfflinger* was sunk; but toward 6 o'clock the German fire slackened very considerably, showing that Beatty's battle cruisers and the 'Queen Elizabeths' had inflicted serious damage on their immediate opponents.

FOURTH PHASE, 6 P. M.

"The Grand Fleet was now in sight and coming up fast in three directions (divisions?). The 'Queen Elizabeths' altered their course four points to the starboard and drew in toward the enemy to allow Jellicoe room to deploy into line.

"The Grand Fleet was perfectly maneuvered and the very difficult operation of deploying between the battle cruisers and the 'Queen Elizabeths' was perfectly timed.

"Jellicoe came up, fell in behind Beatty's cruisers, and, followed by the damaged but still serviceable 'Queen Elizabeths,' steamed right across the head of the German fleet.

"The first of the ships to come into action were the *Revenue* and the *Royal Oak* with their 15-inch guns, and the *Agincourt*, which fired from her seven turrets with the speed almost of a Maxim gun.

"The whole British fleet had now become concentrated. They had been perfectly maneuvered, so as to 'cross the T' of the High Seas Fleet and, indeed, only decent light was necessary to complete their work of destroying the Germans in detail. The light did improve for a few minutes and the conditions were favorable to the British fleet, which was now in line approximately north and south across the head of the Germans.

"During the few minutes of good light Jellicoe smashed up the first three German ships, but the mist came down, visibility suddenly failed, and the defeated High Seas Fleet was able to draw off in ragged divisions.

FIFTH PHASE, NIGHT

"The Germans were followed by the British, who still had them enveloped between Jellicoe on the west, Beatty on the north, and Evan Thomas with his three 'Queen Elizabeths' on the south. The *Warspite* had been sent back to her base.

"During the night our torpedoboat destroyers heavily attacked the German ships, and, although they lost seriously themselves, succeeded in sinking two of the enemy.

"Co-ordination of the units of the fleet was practically impossible to keep up, and the Germans discovered by the rays of their searchlights the three 'Queen Elizabeths' not more than 4000 yards away. Unfortunately they were then able to escape between these battleships and Jellicoe, since we were not able to fire as our own destroyers were in the way.

"So ended the Jutland battle, which was fought as had been planned and was very nearly a great success. It was spoiled by the unfavorable weather conditions, especially at the critical moment, when the whole

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British were anxious for a decisive battle. The battle-cruiser squadron immediately closed in. It was nearer than the battleships and had thirty knots of speed against their twenty, so it got into the fight first. Battle-cruisers were not intended to fight battleships, and it was suspected that German dreadnoughts were ready for action. Admiral Beatty, however, determined to attempt to hold the German fleet until the British battleships could come up. He therefore went in with his battle-cruisers.

It appears that three of his ships went to their death early in the fight because of this attempt. The *Queen Mary*, the *Indefatigable*, the *Invincible*, as dashing ships as ever put to sea, were sunk. It would seem, however, that they inflicted losses upon the enemy that made their sacrifice worth while. They evidently succeeded partially in their purpose. Some of the British dreadnoughts did not get into the fight.

But the lesson is this: Battle-cruisers, with the weight of their armor sacrificed to speed, with fewer big guns than have dreadnoughts, cannot give and take with the latter class of ships. In grips with dreadnoughts they are pretty sure to be sunk. This has been the theory of naval experts all along, but that moot question of the point to which armor should be sacrificed to speed has never before had any actual experiments upon which to base its deductions.

The battle-cruiser was crumpled up and its unfitness to play a leading rôle in naval dramas was demonstrated. The *Queen Mary*, a magnificent ship of her kind, displacing 25,000 tons, could not survive the big shells of the Germans.

THE DREADNOUGHTS ARRIVE

This was the first phase of the battle. It seems to have been after the sinking of these three ships that the British battleship squadron, led by the *Warspite*, arrived. There were four ships in this squadron, and they plunged into the midst of the fight. They appear to have found a fleet that greatly outnumbered them. They unquestionably came in for a tremendous amount of hammering. Every vessel was struck many times. The *Warspite* and the *Marlborough* both suffered many serious hits. The *Marlborough* was torpedoed. Yet neither of these ships sank, both found their way back to port and both will soon be back in the service.

Captain Phillpots, of the *Warspite*, tells a thrilling tale of the experience of his vessel and the punishment she took. His steering gear went wrong and his ship got out of control. She plunged into the midst of the enemy fleet. She drew the concentrated fire of six enemy battleships at one time. She ran amuck and sought to do all the execution possible. Her every gun worked to the maximum.

Yet she stood her punishment and came through. She served the purpose for which a big ship is created. She proved the fitness of herself and her class to perform the purpose for which dreadnoughts are built. She proved the correctness of the theory of those experts who have held that it is wise to sacrifice much possible speed for heavy armor and big guns.

The *Warspite* is a vessel readily comparable with our own *Texas* and *New York*. She has a similar displacement, 27,500 tons. She has eight 15-inch guns where the American has ten 14-inch guns. She is four knots faster than are the American ships and her endurance is probably less. What she did American dreadnoughts should be able to do.

The *Marlborough* is a 25,000-ton ship, of about the class of our *Arkansas* and *Wyoming*. She, too, stood a vast amount of punishment, including that of being torpedoed. This latter test of a modern battleship is very interesting. A number of fighting ships have been sunk in the present war by torpedoes, but they were mostly old vessels and without the resistance of the newer ships. The impression that a torpedo is sure to prove the undoing of the dreadnoughts has not yet been demonstrated, and the survival of the *Marlborough* tends to prove it.

DESTROYERS ATTACK IN DAYLIGHT

A third and most interesting phase of the battle of Skagerrack was the attack of destroyers on both sides. These tiny ships, which were intended to serve the purpose of a screen, to be outriders and scouts of the big ships, had currently been regarded heretofore as being incapable of attacking first-class ships in the day-time. Their method of attack was set down as being one covered by darkness or by fog. Under these conditions destroyers are intended to creep in on the big ships, unleash their torpedoes, and attempt to escape before they are sunk.

It had been known that the Germans had practiced day attacks with their destroyers. This was a possible use of destroyers that neither American nor British fleets had given much consideration. In the North Sea battle, however, before darkness came on, the German destroyers descended upon the British fleet, got in close, and discharged their torpedoes. It is believed that a score of them were sunk, and it is probably true that they did not succeed in destroying any British first-class ship. They unquestionably came near getting the *Marlborough*, however, and it is not shown that such an attack did not prove strategically advisable.

It is believed that the British fleet responded by sending its destroyers into the midst of the German fleet under similar circumstances. Certain it is that something near a dozen British destroyers were lost. The returns do not yet indicate what destruction these vessels created in the German fleet, and it is therefore not possible to draw conclusions as to whether their sacrifice should have been made. The fact remains that destroyers played a very important part in the fighting and were active throughout the engagement. The usefulness of these small ships in a great struggle such as that which took place off Skagerrack is regarded as having been demonstrated.

A point of intense interest to the general public in this first big sea fight of modern navies is the high rate of loss of life aboard ships sunk. On the *Queen Mary*, the *Indefatigable*, and the *Invincible* there was hardly a man saved. Already the United States Navy Department is receiving great numbers of letters from individuals who have suggestions to make as to devices that might be used for saving lives aboard fighting ships. These individuals seem to draw the conclusion that no precaution is taken aboard a battleship for saving life in case the ship is sunk in battle. This is not true. When a battleship is stripped for action there is certainly no place on her deck for boats that might be used for life saving. She has aboard, however, pneumatic rafts, and every man has his pneumatic belt, which would keep him afloat.

ALL DIE WITH THEIR SHIP

In time of battle, however, there is no time and no inclination to make use of these devices. When a battleship is hit and seriously damaged there is no way of knowing whether or not she is about to sink. It may be possible that she will remain afloat for hours, or that she may not sink at all. Her purpose is to continue to damage the enemy to the greatest possible extent. A single final shot from a sinking ship may be the blow that will turn the tide of battle and the destiny of empires.

A damaged battleship, therefore, continues to fight. The men remain in the fire rooms, in the turrets, at their guns. Every man continues that particular job which is his in fighting the ship as long as she may strike a blow. It therefore happens that when the battleship goes down there is practically nobody on deck, and there is no man who may leave his post in time to put on a life belt or launch a raft. Quite naturally, every man dies with the ship.

The theory of fighting the ship until the last moment seems to have been exemplified by practically all those that were sunk in the recent battle.

The battle of Skagerrack seems to have justified the position which has long been taken by the experts of the General Board of the American Navy, a position which has met the approval of most American authorities and which has been crystalized into the programme which America has followed. The General Board has recommended for fifteen years that the United States continue the policy of placing its chief reliance in big ships. Since the dreadnought came into being it has maintained that that vessel should be made the backbone of the fleet. If appropriations were sufficient to provide but one class of ships, the General Board has insisted that they be dreadnoughts.

AMERICAN PROGRAMME JUSTIFIED

There is a constant tendency on the part of the public to go off at a tangent in its enthusiasm for the class of ship that at a given time is attracting wide attention. Last fall, for instance, the public clamored for many submarines and favored disregarding appropriations for dreadnoughts or battle-cruisers. Later, the battle-cruiser has been attracting much attention to itself because the incidental clashes of the present war have been battles between scout ships. So the clamor this spring has been very largely for battle-cruisers.

The dreadnought has attracted very little attention because she has not heretofore been in the fighting. The public did not see that the very existence of British dreadnoughts in the North Sea resulted in the bottling up of all Germany. It did not generally realize that the battleship was performing its purpose without the necessity of fighting. The present clash, however, demonstrates that in the final issue it is the dreadnought which means victory or defeat.

This battle seems also to have proven the value of that other branch of the fighting fleet which has been given most attention in the American Navy, the destroyer. The many opportunities for usefulness of and the great possibilities of execution which rest with these little ships seem to have been demonstrated. The battle of Skagerrack seems to have shown that the United States has chosen wisely in selecting the units upon which she would depend in making a fleet from appropriations that made it possible to have all the units desired.

The usefulness of the battle-cruiser or the scout cruiser has not been disproven, but the inadvisability of depending upon the fast lightly armored vessels in a clash in which dreadnoughts are engaged is shown. The cruiser is a necessity in any modern fleet unless that fleet is willing to grant certain advantages to its rivals which are provided with these fast ships. The theory that a time would come when they would displace dreadnoughts must, however, in the face of the new facts, be given over.

The battle of Skagerrack teaches less of the value of guns of various calibers than of most of the vital problems of the navy. All the fighting was close in. The marksmanship was, therefore, not very exacting. The test on the guns was not great. Any gun and almost any gunner ought to be able to make hits at six miles. The advantage attributed to British guns and gunners had little opportunity to demonstrate itself. Likewise are the results in ships sunk by the British cruisers and dreadnoughts still unknown. The deadliness of the great British 15-inch gun cannot yet be said to have been determined.—From *Sea Power* in *Scientific American.*

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THE SIZE OF NAVAL GUNS

Are Twelve 14-Inch or Eight 17-Inch Guns to be Preferred?

By Lieut. (J. G.) Richmond K. Turner, U. S. Navy

At the beginning of the present war England was the only power possessing naval guns as large as 15 inches, the largest calibers mounted by other nations being either 12 or 14 inches. We now hear that Germany is building 17-inch guns, that England has 17- and even 18-inch guns under construction, and that the United States may abandon the 14-inch in favor of the 16-inch. The question has been raised as to why this country, having built a 16-inch gun some years ago, did not immediately adopt it and discard the 14-inch in order to keep ahead of foreign construction, the assumption being that the largest and most powerful gun must necessarily be the most effective.

In an analysis of a subject such as that of effective gunnery we must reject all features that are based on chance and hold to those that will apply in the greater number of cases according to the laws of probability and error. For instance, last year, after the second North Sea fight, it was very frequently asserted, because the range was very great and one of the few effective hits on the English vessels was in one of the *Lion's* machinery compartments, that the range for modern battle had become so great that no shell could hope to penetrate side armor, that therefore the hit in question must have been a "plunging" or falling hit through the protective deck, and that therefore plunging hits were the only ones that could now be effective. Opponents of heavy armor protection also seized upon the situation and said that since ranges were now to be so great, we may as well discard or greatly reduce our armor! The fact is that there are no better reasons for either assertion than before this battle occurred, and the reasons that previous to the war dictated the use of guns and armor of a certain character seem to apply equally well now—though this does not mean that we should not take advantage of certain *known* truths, such as the increased range to be expected and the *possibility* of chance hits such as that on the *Lion.*

Therefore in what follows attention will be called to the *most probable* events in a naval battle and less attention devoted to merely *possible* happenings. And obviously, we must leave out the question of training, because that is one of personnel, and we must confine ourselves to material only.

Most of the sound arguments advanced for or against an increase in the caliber of naval guns may be grouped under four general heads:

1. The number of guns that may be carried.
2. The relative destructive effect of two shells of different calibers.
3. The number of hits that may be made with two different batteries in the same interval of time.
4. The "life" of a gun, or the number of rounds it may fire before losing its accuracy.

A ship's effectiveness of gun fire is measured by its capability of destroying another ship while suffering the minimum damage herself: in other words, by the destructiveness of her fire relative to that of the other ship.

Suppose we are building two ships of equal size, speed, and armor protection, and on one we intend to mount 17-inch guns and on the other 14-inch guns. Obviously, since the same weight in both ships is to be allowed for ordnance purposes, we can not carry as many of the larger guns as of the smaller. Thus if we put four 3-gun 14-inch turrets on one ship we will probably be content with four 2-gun 17-inch turrets on the other. This is about the ratio of light to heavy guns usually admitted in discussions as to the relative advantages of two different batteries. We may say then, in general, that if we choose light guns instead of heavy we may have about 50 per cent more of them.

In examining the destructive effect of armor-piercing shell against a ship it is apparent that we can put the enemy ship effectively out of action by sinking her or by so disabling her crew and propulsive machinery that our torpedo vessels may sink her. In both cases the same result is attained: that is, she is destroyed whether we sink her by means of shot holes in her hull below the water line or send so many explosive shells into her machinery compartments from above the water line that she is forced to fall to the rear. In the one case destruction is caused by the direct piercing effect of the projectiles and in the other by their explosive effect.

It is immediately apparent that there can be little difference between the holes caused by 14-inch and 17-inch projectiles, because in either case so much water is admitted that it would require but few such holes to sink the ship. Therefore, from this standpoint there is a distinct advantage in having the greater number of smaller projectiles, provided they penetrate the hull.

If we examine the explosive effect of the two shells the same advantage holds to a certain extent. A 14-inch shell weighs but 1400 pounds and a 17-inch about 2500 pounds, but the effects of their explosion in a ship's compartment are much the same. The high order burst of even a 14-inch shell is so terrible, the increase in pressure being so great and the fragments so numerous, that it is inconceivable that any machinery or human beings in the compartment could escape destruction. In other words the 14-inch shell will so effectively put a whole compartment out of commission that there is little use for the extra effect that would result from the explosion of a larger shell. If a 17-inch shell strikes a turret it is more likely to disable it than is a 14-inch, and its effect is decidedly more destructive than the 14-inch when it bursts on the open deck or against the upperworks of the vessel. It is only by penetrating hits below the water line or bursts in the machinery compartments that a ship is put completely *hors de combat*, however, so it must be admitted that it is probable that the destructive effect of a salvo of twelve 14-inch shells is, with equal accuracy and penetrative power, considerably greater than that of a salvo of eight 17-inch shells.

The direct penetrative power of armor-piercing projectiles against homogeneous nickel-steel armor is usually computed by means of what is known as the de Marre formula, which is:

$$V = K\frac{d^{.75}e^{.7}}{p^{.5}}$$

where V is the striking velocity of the projectile, *p* its weight, *d* its diameter, *e* the thickness of armor penetrated, and *K* a constant. The same formula is used in the case of face hardened armor by assigning a "figure of merit' of 1.5, or by taking the required velocity 1.5 times as great as that given by the formula. The velocities of 14-inch and 17-inch projectiles must then be, for piercing the same plate, in the ratio:

$$V_{14} : V_{17} = \frac{d_{14}^{.75}}{p_{14}^{.5}} : \frac{d_{17}^{.75}}{p_{17}^{.5}}$$

or

$$V_{14} : V_{17} = 1.154 : 1,$$

the smaller shell requiring 15 per cent more striking velocity than the larger.

Furthermore, the larger projectile holds its velocity longer during flight, since, by Mayevski's differential equation for the retardation caused by the air:

$$\frac{dv}{dt} = -A\frac{d^2}{p}v^n.$$

Therefore, if the two projectiles leave with the same velocity the lighter will at once begin to lose velocity faster than the heavier by the ratio:

$$\alpha_{14} : \alpha_{17}\frac{d_{14}^2}{p_{14}} : \frac{d_{17}^2}{p_{17}},$$

or

$$\alpha_{14} : \alpha_{17} = 1.211 : 1.$$

Thus, if the two guns have the same muzzle velocity the 17-inch projectile will arrive at its target with the higher velocity, and conversely, if the 14-inch will just penetrate a certain thickness of armor at, say, 15,000 yards, the 17-inch should be able to penetrate the same armor at a much greater range.

It appears from the above that at very great ranges the 14-inch shells will not be effective except against the upper works of a ship, and that armor will turn them aside much more readily than it will the 17-inch; at smaller ranges, however, the greater number of light shells will have a greater effect than the smaller number of heavy projectiles. This deduction accords exactly with the observed facts.

Certain inaccuracies are inherent in the flight of projectiles and in the aim of naval guns. The inaccuracies of flight may be laid to such things as small differences in the weights of the projectile and the powder charge, more or less unsteady flight due to the fact that the center of gravity of the shell may not lie exactly in its axis of rotation, slight differences in the action of the powder upon firing, different wear in different guns, and many other small causes. The total effect of all the inaccuracies is an error whose average is nearly the same for all large guns, if the angle of fall is the same. Therefore, if the 14-inch and the 17-inch shell have the same angle of fall it is to be expected that we will get 50 per cent more hits with a twelve-gun battery than with an eight-gun battery.

As the range increases the angle of fall of the 14-inch increases much more rapidly than the 17-inch, since the latter keeps its velocity longer. There will be a certain range, therefore, when the probabilities of hitting, which depend upon the errors and thus upon the angle of fall, will be exactly the same for the 14-inch 12-gun battery as for the 17-inch 8-gun battery. The larger shells would now, with an equal number of hits, be much more effective, since their penetrative power is so greatly superior. There is also a certain range, less than the range where the chances of hitting are equal, where the destructiveness of the two batteries would, in the long run, be exactly equal. If we expect to fight our naval battles at ranges less than this certain range the battery of twelve small guns is to be preferred to that of eight large guns, while if we expect to fight our battles, *as a rule*, at greater ranges, the large guns will be the more effective.

Naval guns do not fire at a target at sea under the same conditions as do emplaced guns. The latter may be aimed by laying them at vertical and horizontal angular distances from some fixed reference point, and when fired will send their projectiles to a certain definite point on the earth's surface, neglecting errors. Naval guns, on the contrary, must, due to the vessel's motion, be aimed by a man some place on board the vessel itself, who must be able to see some part of the target at which he is firing. Under the present system of spotting the fall of shot the spotter is on a platform about 125 feet above the surface of the water, and he must be able to see the waterline of his target. Thus the utmost possible range at which naval fighting may be carried on is limited by the horizon of the eye of a man about 125 feet above the water. The distance of this horizon is 25,800 yards, so that at about 25,000 may be considered the greatest possible range for vessels firing under present conditions.

If the existence of a critical range for two batteries, such as that defined above, be admitted, then very evidently there must be some certain battery of guns of a certain size, which will be more effective at ranges up to 25,000 yards than any smaller number of larger guns. There will thus be no advantage in going to a larger gun, but on the contrary a positive disadvantage, since at such ranges as have obtained in the present war the disproportion will be even greater. And unless we can be sure of having a faster and more mobile fleet than an enemy armed with even smaller but more numerous guns we can not be sure that he will not close in and defeat us at comparatively short ranges.

The limit of *effective* range for a battery, from what has been said, is seen to be that range at which enough hits may be scored to sink the enemy ship before the ammunition is exhausted. The striking velocity of the projectiles must be sufficient to penetrate the armor protecting the vitals of the ship at that range. Ordinarily this must be considered to be the side armor, since the protective deck armor may only be penetrated by a plunging, or nearly vertical, fire, and hits of this character are chance hits. It will be interesting to compare, roughly, the relative effectiveness of the 14-inch and 17-inch batteries we have discussed, at the range limit of 25,000 yards, and to find the weak and the strong points of each.

tionately than in small calibers, and thus the eroding action of the gases is much greater in the former. The life of an infantryman's rifle, for instance, is several thousand rounds, while the life of a large naval gun is only a few hundred rounds. If the muzzle velocity, and thus the powder pressure and temperature of combustion, is lowered, the erosion of the bore will be smaller. So there is always an excellent reason for hesitating to adopt a larger gun with a very high velocity, particularly since the life cannot be always accurately predicted.

Few of the elements that have been here considered are mathematical, and most of them must be judged according to the ideas of experienced men. One artillerist, for instance, may hold that a shower of light shells will be best, since it will quickly disable an enemy through putting his guns out of action; another may believe that it is best to attempt to sink the ship by shells penetrating the armor and exploding inside. Others base arguments for or against larger calibers on the single premise: better speed than the opponent. The first of these would use speed to stay out of the enemy's range and, with heavier guns, slowly sink his vessels; the second would rather have many light guns and by using superior speed close with the enemy until his heavier guns were at a disadvantage. If we could have as many heavy, high-powered guns and with as long a life, there would be no question of choosing lighter guns. But if we reduce the muzzle velocity considerably, and have fewer of the heavier type, careful and deliberate judgment must be exercised to determine upon which side the balance inclines.—*Scientific American.*

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NAVAL OPERATIONS AGAINST TSINGTAU

The permanent seacoast defenses of Tsingtau and Kiao-chau harbor consisted of the following batteries:

Hui-tsch-uen Huk.
  2 24-cm. guns mounted en barbette, with shields.
  3 15-cm. guns mounted in turret of concrete and steel.
  Position finding station in armored turret.
Auguste Huk.
  5 15-cm. guns.
North of Auguste Huk.
  4 15-cm. guns.
Tai-hsi-tschen.
  4 21-cm. guns.
Yu-nui-san.
  4 8-cm. guns.

Signal station on Diedrichs Berg.

Batteries for Ilits Iluk and Kap Jaeschke had been projected, but not constructed.

The war vessels which Germany had at Kiao-chau were boats of such inferior strength and speed that they could not be sent to sea as commerce destroyers, so they were kept in the harbor and finally sunk.

AUSTRIAN

Cruiser............*Kaiserin Elizabeth*.....1890....8 6-inch guns.

	Rounds Fired					
	12-inch	10-inch	8-inch	7.5-inch	6-inch	Total
Suwo	--	39	--	--	--	39
Iwami	20	--	9	--	--	29
Tango	13	--	--	--	1	14
Triumph	--	32	--	34	--	66
	33	71	9	34	1	148

The marking was done by the *Tone*, stationed near Tai-kung-tau.

1st run, light bad, firing good; 2nd run, light better, many shells burst on Iltis Berg.

On October 1 it was reported from Tokyo that the Japanese siege guns had sunk the German destroyer. Also that the Japanese mine sweeper *Nagato Maru* was blown up and sunk, and that another mine sweeper was damaged. Several days later another mine sweeper was reported sunk in Lao-shan bay.

On October 6 the *Suwo* at 1:00 P. M. commenced to bombard Iltis Fort with her 10-inch guns at a range of 16,400 yards. Finding that the projectiles were dropping 3000 yards short, she ceased firing. The *Triumph* then took up the firing with the same caliber guns and had the same experience.

On October 10 the *Suwo* bombarded Iltis Fort.

On October 14 the *Suwo*, *Tango*, and *Triumph* bombarded from north of the island of Tai-kung-tau. The *Suwo* was given a list of 3 degrees and concentrated her fire on the fort at *Hui-tschuen* Huk at 17,000 yards. Forty rounds were fired with very good results, considering the extreme ranges. While the cannonading was in progress, a Japanese aeroplane flew over the Hui-tschuen Huk fort, dropped bombs and observed the range of the projectiles. The fort replied to the bombardment, but did no material damage to the attacking fleet.

By October 15 the navy had cleared the Sha-tsy-kou bay of mines, and the army established another landing place and depot there. This depot was used principally to supply fuel, provisions, and supplies other than ammunition.

On the night of October 17 the cruiser *Takachiho*, while on patrol duty outside of Tsingtau, was blown up by the German torpedoboat *S-90*. Casualties: 28 officers, 54 non-commissioned officers, and 189 seamen perished. The torpedoboat was beached in Chinese waters.

On October 19 the German Embassy in Washington announced that the *Triumph** had been compelled to withdraw from the bombarding fleet on account of damage inflicted upon her by fire from German howitzers.

On October 26 the *Suwo* bombarded the forts.

On October 27 the *Tango* and *Okinoshima* bombarded Iltis Fort, firing 20 rounds each.

On October 28 the *Tango* and *Okinoshima* bombarded during the afternoon. The *Tango* fired 20 rounds, 5 shots hitting the battery near No. 1 redoubt.

On October 29 the *Suwo*, *Okinoshima*, *Tango*, and *Triumph* bombarded Iltis Berg, 80 meter hill to the south of Iltis, and a small fort below it, between 9:30 A. M. and 4:30 P. M. The shooting of the *Triumph* and *Tango* was very good.

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* The *Triumph* was torpedoed and sunk in the Gulf of Saros, May 26, 1915.

	Rounds Fired			
	12-inch	10-inch	7.5-inch	Total
Suwo	--	55	--	55
Tango	58	--	--	58
Okinoshima	--	18	--	18
Triumph	--	59	7	66
	58	132	7	197

On October 30 the bombardment of the preceding day was renewed, the *Iwami* replacing the *Tango*. The guns at Hui-tschuen Huk replied occasionally but all shots fell short. The extreme range of this fort was ascertained to be about 15,700 yards—241 rounds were fired.

On October 31 the *Suwo*, *Iwami*, *Tango*, *Okinoshima*, and *Triumph* bombarded from 9:00 A. M. to 4:30 P. M., mostly at the forts below Iltis, and at the seacoast forts at Hui-tschuen Huk and Auguste Huk. The batteries at these two latter forts returned the fire.

On November 1 the *Suwo*, *Iwami*, and *Triumph* fired 110 rounds between 9:00 A. M. and 4:30 P. M.

On November 4 it was blowing too hard to bombard.

On November 5 the *Tango*, *Okinoshima*, and *Mushima* bombarded Hui-tschuen Huk from south of Hai-hsi peninsula.

On November 6 the mirage was too bad for firing.

On November 7 the Germans surrendered.

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WARSHIP DESIGN AND THE PRESENT WAR

So far as the naval aspect of the present war is concerned, the experience of such fighting as has already taken place has been sufficient thoroughly to justify the design of the vessels forming the Fleet at the time of the outbreak of the war. Mere fighting only, however, has probably done even less in this direction than has the experience of the last eighteen months of waiting and patrolling, conditions under which habitability and seaworthiness—qualities that do not show in annuals or parliamentary statistics—rank far higher than others for our purposes. The question that is constantly before the mind of all interested in warship design—and especially does this apply at the present time to neutral designers and to the officers of smaller navies—is whether this combined experience has yet been sufficient to enable any accurate deductions to be made as to the future trend of design. To some extent it has been sufficient, but in one respect at least—fleet actions—experience is not great enough to permit clear deductions to be made. So far, however, as the war has proceeded it cannot be doubted that the general suitability of the vessels of all classes to the purposes for which they were designed has been proved again and again, and this, moreover, applies not only to the later ships but to those of older types, whose utility has been most marked in operations in which it would have been sheer folly to employ newer units.

For anyone so minded, it is an extremely interesting study to take up and carefully re-digest some of the, at the time of publication, apparently extremely authoritative articles on the design of warships which appeared in large numbers during the period between the completion of the *Dreadnought* and the outbreak of the present war. Viewed in the light of the experience of the past eighteen months, any attempt to analyze their intrinsic worth is liable to prove so much waste of time, at any rate as regards the majority of them. This is not so much because the arguments presented were necessarily fallacious. On the contrary, in many cases they were extremely sound; but because in many cases the articles dealt only with special circumstances and not with either the requirements of fleet units in a fleet at war or the principles that should govern the design of warships in order to attain a definite object. Taking, for instance, any good series of publications, we frequently find that although the line of argument on the questions, perhaps, of numbers *versus* size, or the relative value, weight for weight, of armament and protection, are perfectly sound and likely to reappear in principle immediately after the war is over, only very few of them are at all applicable to the peculiar conditions under which the Royal Navy is now engaged in dealing with the enemy. Many of the articles, of course, are now utterly valueless, and more are really now only of academical interest. Nevertheless, even these are of value as showing the lines of thought followed by many whose training and experience should at least render them capable of expressing serious opinions. A few, however, stand out as being of peculiar interest and value at the present time. Among these are those read by the late Sir William White in 1911 to the Society of Naval Architects and Marine Engineers in New York and by Mr. T. G. Owens in April, 1914, to the Institution of Naval Architects in London. Both papers dealt with the principles of battleship design; both are sufficiently recent—especially the latter—to be fully applicable to the principles of battleship design at the present day as well as for some time to come, and it is interesting to consider in the light of the views expressed by these two designers how warship design may have been effected by the present war.

Now, both papers dealt with battleships and battleships only. So far, only the battle-cruisers have seen fleet actions, and only two of these. The one off the Falkland Islands was fought against a much weaker force, though that off the Dogger Bank certainly provided some more interesting information, as the opposing forces were more evenly matched. In the former case the German 8-inch guns were opposed to the British 12-inch; in the latter the German 11-inch and 12-inch guns were opposed by the British 12-inch and 13.5-inch weapons. That is, in both cases, the Germans were outgunned. All theoretical considerations of the size of gun to be adopted and of the armor required to minimize the effect of the enemy's projectiles must necessarily be based on an estimate of the decisive battle range at which it is anticipated that actions will be fought. In the event of lack of actual experience, that of target practice under conditions expected to resemble those of actual warfare as closely as possible must be taken as forming the best possible guide. In the Russo-Japanese war the decisive battle range was about 5000 yards. Sir William White, in his paper referred to above, considered the battle range rather more, and in Mr. Owen's paper the opinion was expressed that it lay in the region of 8000 yards, and that the range of probable maximum vision was about 12,000 yards. That these estimates are remarkably short of the mark was proved very definitely at the battle off the Falkland Islands, when the British battle-cruisers were hit by the 8-inch German shells of the *Scharnhorst* at a little under 10,000 yards, and our ships did much of the damage to the Germans at about 12,000. This was corroborated by the action off the Dogger Bank, when the firing commenced at more than double the range assumed by Mr. Owens in his paper, and the official dispatch of the action contained the remarkable statement that "we commenced hitting at 17,000 yards."

Mr. Owen's paper is certainly the most complete statement of the factors to be taken into account in battleship design, together with their sequence of importance, which is available for general reference. Having distinctly obviated the inclusion of many varying factors by the acceptance of "such a speed as not to be inferior to that of our possible opponents"—that is to say, by not contemplating slower vessels with increased armament proportions or *vice versa*—he pointed out that the primary weapons should be of the smallest caliber and weight necessary to carry an efficient bursting charge through the maximum thickness of protecting armor on an enemy's ship at the range of maximum vision. Now, in the Dogger Bank fight it is said that German belt armor-plates were carried bodily inboard without being perforated, and that at a range previously regarded as impracticable. Armor will not keep out heavy shell. Its value lies really in the fact that in order to perforate it, a less dangerous projectile must be used than would be the case if the armor were either thinner or absent. At ranges such as those at which the Dogger Bank action was fought the heavier gun was amply justified, and under the circumstances it may confidently be stated that an even heavier weapon than the 13.5-inch would have given correspondingly better results. Even with its great accuracy and flat trajectory the 50-caliber 12-inch gun is too small at 12,000 yards when used against vessels of the "Derfflinger" type. The chances of hitting, and, if hitting, of doing far greater damage, are enormously increased with the larger-size weapons now mounted. In this connection it is interesting to note the recent references in the daily press to the German 17-inch weapon, with which, it has been suggested, some of the German battleships may have been re-armed. Nothing is more improbable.

As regards the disposition of main armament, and the concomitant problem of number of heavy guns, we may regard each of the battle-cruiser actions as corroborating both Sir William White's and Mr. Owen's views as to the desirability of limiting the number of heavy guns to eight. Nothing occurred in either action that went to prove that triple turrets possessed the slightest advantage nor did anything disprove their anticipated defects. Both actions—and this was realized both by pursuers and pursued—corroborated the value of center-line and superposed turrets, and to this extent, as was prophesied by Sir Philip Watts in the course of the discussion on Mr. Owen's paper, showed that the partly advocated adoption of a flush-decked vessel, with all four turrets at approximately the same height above the waterline, would obviously have been a mistake. The advantage of ample ahead and astern fire has been thoroughly proved. As regards the oft-debated question of sacrifice of armament and protection to speed, it may be remarked that we have heard hardly any debate take place on the relative merits of battleships and battle-cruisers since the Dogger Bank action. If the *Lion* and her sister ships had happened to be capital ships of the "Iron Duke" type, there is not the slightest doubt that the Germans would have made use of their superior speed in order to avoid action, but if the position had been reversed and the *Lion* and her sister ships had fallen in with, say, four ships of the "Kaiser" class, what would the result have been? Probably considerably more damage to both sides, but with an even more definite result of the same nature. In the light of what occurred last January, it is indeed difficult to imagine that battleships of the "Kaiser" class could have made proportionately better use of their extra turret, while the higher speed of the British battle-cruisers would have enabled them to take up such a position as to delay the German progress until a final solution of the battle had been achieved.

On the point of speed, both fleets were very evenly matched a year ago, but it must not be overlooked that the "paper" speeds of the *Moltke* and *Seydlitz* were only attained on trial by excessive forcing, whereas the British vessels were by no means pushed to their maximum on their official trials, and though reputedly slower in consequence, were able in this emergency slightly to exceed the speed of the German vessels. Nothing has yet occurred in the course of the war to affect seriously the views previously held on the subject of the auxiliary armament of battleships. If anything, the utility of the 4-inch weapon as an anti-torpedo weapon has been thoroughly vindicated, although it has mainly been used against submarines. That it should be placed high up instead of on the main deck is also certain.

The extensive use of mines and torpedoes in the present war has caused the keenest attention to be paid to questions of under-water protection and internal subdivision. However thoroughly these features of warship design had been investigated before the war, recent experience has shown that adequate defense against the modern large-size torpedo or mine is very difficult to provide, except at the expense of other qualities too valuable to sacrifice, and, further, that the proper defense should lie less in the ship itself than in the extended use of auxiliaries acting in concert. Internal protection in the form of additional longitudinal bulkheads running parallel to the sides has always been a feature of recent German naval designs, but such protection is impossible in small craft, and in their case unfortunately damage by mine or torpedo must be accepted as fatal. Even in a big ship it is almost impossible to guarantee safety, and for some time to come the below-water vulnerability of capital ships must be regarded as a particularly weak point.

Of the two salient qualities of British warship design referred to above—those of habitability and seaworthiness—it may be remarked that in the course of the war the proofs of their excellence and necessity have cast most interesting lights on many foreign designs, and particularly on those of the German navy. Nearly every recent German ship of any size has been over-gunned, and hence has had to carry an unduly large crew, with the result that in many of their newer ships, especially the battleships of the "Nassau," "Helgoland" and "Kaiser" classes, overcrowding of the crew has been a notorious defect. This applies even more to their torpedo craft, of which surprising little has been heard during the present war. If this chronic lack of habitability be coupled with what experience has shown to be the case even with our own ships—that is, that for constant sea-keeping it is generally necessary to keep the main deck gun ports and scuttles closed—then it is fair to deduce that under war conditions the personal comfort of the crews of the German battleship fleet must be reduced to a minimum, especially as their main deck 6-inch gun batteries are uniformly nearer the water than are our own, and they consequently cannot be kept open as long as ours. In harbor this is of little consequence, but the radical change of ventilating conditions on proceeding to sea is bound to make itself felt to a considerable extent.

So far, we have not touched on the question of machinery design, as affected by war experience, but all that has gone to corroborate the soundness of the Admiralty policy in warship design as a whole has been, if possible, even more emphatic where the propelling machinery of the ships has been concerned. The whole-hearted adoption of oil fuel alone has been of inestimable advantage. Perhaps the most remarkable feature of the performances of all the ships has been the almost universal reliability of engines and boilers, and particularly those of the destroyer flotillas, for the newer battleships have had hardly enough sea-keeping to tax their strength seriously. There are instances of vessels of the former type having steamed distances without undergoing elaborate overhaul that appear almost incredible. Much of this, of course, is due to the adoption of the steam turbine; perhaps even more is due to the care lavished on the machinery by the engine-room staffs. If, as is probable, statistics of some of the steaming performances are officially published in the nebulous future called "after the war," the records will prove to be astonishing tributes to the reliability of Admiralty machinery when worked to its fullest capacity under the stress of war conditions.

To revert to the two papers referred to, it is certainly remarkable that, as far as present experience has gone, both authors formulated arguments for designs which have received striking corroboration in practice. It will be remembered how severely the design of the battle-cruisers was criticised in recent years by those who held that too much had been sacrificed to the attainment of high speed—a point on which both Sir William White and Mr. Owens were silent. Both, however, kept strongly to the feature of "moderate" displacements. Neither laid stress on the unknown factor of accuracy of marksmanship, upon which obviously so much must necessarily depend. That the high-speed ship has justified its existence is very certain; that many foreign designs of even recent date have received an added impetus to obsolescence is equally sure. And as it happens, among these is a considerable number of capital ships which now figure in the German and Austrian navies.—*The Engineer.*

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THE PARODI PERISCOPE

We illustrate in Figs. 1 and 2, reproduced from the *Rivista Marittima,* the periscope recently patented by Professor Parodi. In this periscope, the Italian review states, no essential novelty is introduced from the optical point of view, except that a larger use is made of lenses of toroidal section. At the top of the optical tube *a*, which rises from the submarine, is fitted a total reflection toroidal prism *b*, arranged so as to form both an achromatic converging lens and a total reflection prism, the curves of the various faces being determined so as to secure this result. The rays from the toroidal prism *b* first pass through a pair of plano-convex condensers *c*, which produce a parallel beam extending to a converging lens, toroidal in shape, which is added as shown at *d*. The image reflected by the toroidal prism passes to the lower end of the tube through the two plano-convex condensers *e* and a converging lens marked *f*.

A total-reflection toro-prismatic system, *g*, is fitted at the lower end of the optical tube, having its conical reflecting surface at right angles to the corresponding surface of the upper toroidal prism. The novelty of the Parodi device is that the luminous rays from the horizon are so deviated that the image of the objects is given on a cylindrical screen *h* placed round the lower prism, as shown in Fig. 2. The screen reproduces the whole horizon visible to the observer placed at *i*, and who views it through the cylindrical glass screen *j*. The image can be enlarged. The conditions of an observer who views the horizon direct are thus exactly reproduced, there being added the possibility of directing from the screen the principle problems relating to the course of the boat by combining the picture with a fixed index and the indications of a compass which are projected on the screen *h*, as shown in Fig. 2.

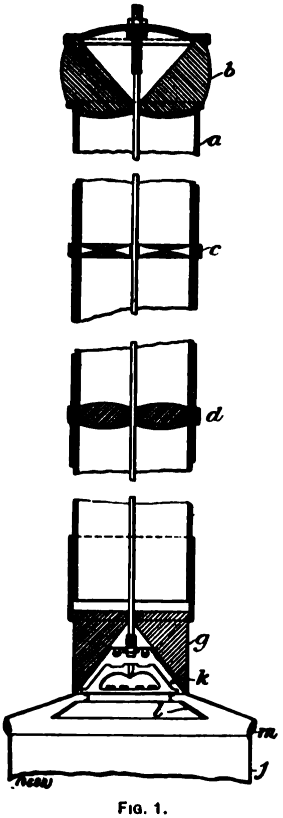

Fig. 1.

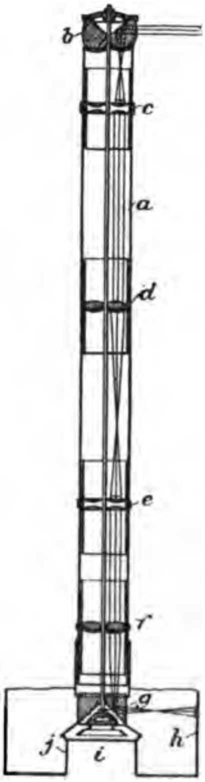

Fig. 2. 1841

The compass, marked *k* in Fig. 1, has a transparent card, and is fitted in the conical cavity of the lower prism; it is lighted from the top, and there is thus projected on the screen the entire graduation of the card through the conical mirror *l* and the annular lens marked *m*. The apparatus is destined to act as a "perigraph," but it can act also as a periscope by simply placing in front of the lower prism *g* a simple and supplementary rotary ocular device.

The Italian journal from which we quote cannot vouch for Professor Parodi's "oloperigraph" being found in everyday practice so simple and perfect as it appears at first glance. It believes that the great difficulty will be a lack of light for a clear direct sight; in regard to this it should be noted that the images are projected inside a kind of dark chamber, cylindrical in shape, limited by the screen, and are thus viewed under very favorable conditions.—*Engineering.*

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THE LEWIS MACHINE GUN

A trial was recently made at the camp at Plattsburg, N. Y., of the Lewis machine gun and the Benét-Mercier machine gun by a board appointed by Major-General Leonard Wood, U. S. A., commanding the Eastern Department. The members of the board were Capt. Halstead Dorey, 4th Inf., A.D.C., Lieuts. Townsend Whelen, 29th Inf., and J. F. Taulbee, 2d Cav. Capt. W. R. Smedberg, jr., 2d U. S. Cav., was present during all the trials. In their official report to the War Department the board state their unanimous opinion that the Lewis machine gun showed superiority in every test over the Benét-Mercier gun, which is the regular machine gun equipment of the U. S. Army. This was particularly emphasized in the night firing tests.

Particular attention was given to the sand and mud tests. The loaded magazines were filled with wet and dry sand and were fired without cleaning, except removal of such sand as fell out when magazines were shaken. The Lewis guns fired the required number of shots in one minute and three seconds, while the Benét-Mercier guns fired only eight or ten shots in five minutes of firing and went out of action for the balance of the tests, having become jammed and unable to continue the tests. The Lewis gun immediately thereafter fired 188 shots in fifty-three seconds, to demonstrate its functioning without the sand being removed from the gun.

The most interesting test, however, was when the magazines of both guns were filled with thick mud, guns remaining uncleaned after the sand test. The Lewis gun performed in forty-eight seconds, while the Benét-Mercier guns were unable to function after the sand test, and therefore did not even attempt to enter the mud tests. After the conclusion of these tests the Lewis guns fired twenty shots with deformed cartridges and battered shells in three seconds.

The Benét-Mercier guns used were those of the 2d U. S. Cavalry. Lieut. Philip Gordon, commanding the machine gun troops of that regiment, stated that they were in the best possible condition at the time of the tests. The official report concludes as follows:

"In the opinion of the board the mobility of the two guns is practically the same. Each can be handled by one man; the size of the crew depends simply upon the amount of ammunition carried. The superiority of the Lewis gun in every other particular was clearly demonstrated, the following special advantages being noted:

"(1) Simplicity—this was especially important in the night work; (2) the comparative rapidity and ease with which a fresh magazine may be attached and removed in case of jam; (3) more efficient cooling device; (4) ease in cocking piece for first shot; (5) comparative ease in reduction of jams; (6) remarkably satisfactory action in sand and mud tests, and with deformed cartridges."

Following the order of the War Department for 250 Lewis machine guns, which have already been inspected by Major Stewart, U. S. A., and shipped to the Mexican border, the manufacturers of the gun, the Savage Arms Company, have arranged to send Col. J. J. Dooley, N. G. S. M., nationally known as a rifle and machine gun expert, to the several headquarters in Texas to supervise the instruction of machine gun companies in the use of Lewis guns, at the request of the Government. Being light enough for one man to carry in open order skirmishing, it is probable that new drill tactics will be evolved. The War Department has given an order for 100 Lewis guns in addition to the 250 previously reported. This is the gun invented by Col. I. N. Lewis, U. S. A., retired, and it has been used in great number by the Allies in the war in Europe.—*Army and Navy Journal.*

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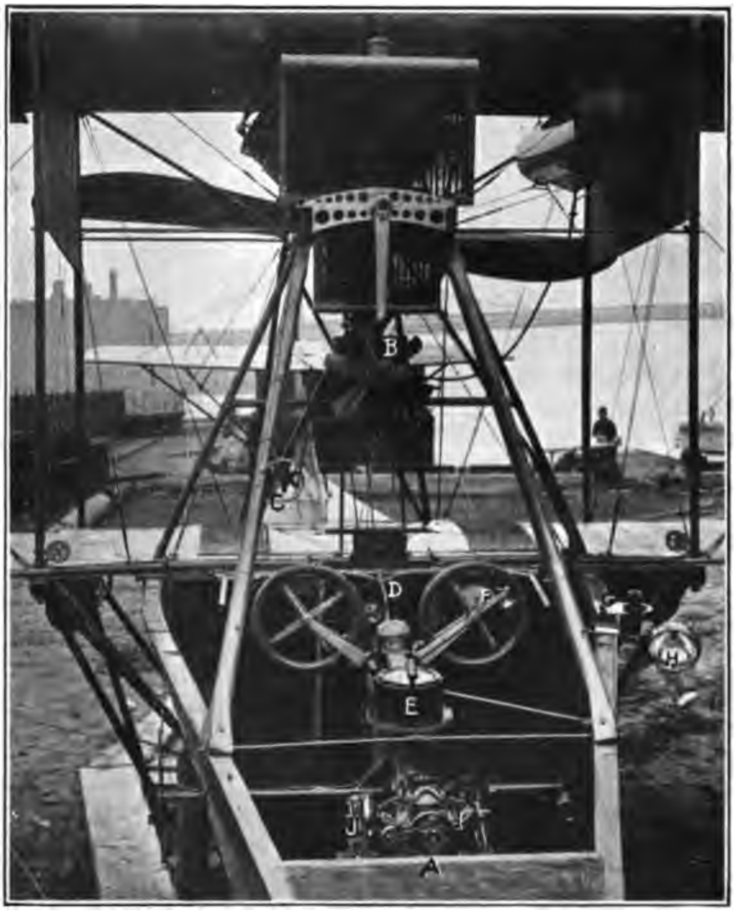
STABILIZING WAR AEROPLANES WITH GYROSCOPIC CONTROL

The basis of gyroscopic control for aeroplanes is the gyroscopic unit of four gyros nested in a cardan ring. These four gyros, working in connection with a force impressor system, maintain the ring in a perfectly horizontal position regardless of the movements of the aeroplane. In other words, the aeroplane moves around the gyro unit, and in doing so makes electrical contact, which operates controls that bring the aeroplane back to the same horizontal position as the stabilizing unit. By arranging this unit so that the ring is horizontal when the aeroplane is in the position for normal flight, any deviation from that position sets in motion the forces which return it to that position. The two segmental contacts *I* and *J*, Fig. 1, are secured to the ring mountings, while the brushes shown bearing on these contacts are fastened to the frame of the aeroplane. In this way any motion of the aeroplane in one direction moves one brush over the contact segment, while a movement in the other direction moves the other brush. Should there be movements in both directions, both brushes would move in proportion to the aeroplane movement in either direction.

Each segmental contact has a neutral section on which the brushes rest when the aeroplane is in normal position. No control movement takes place in this position, but a movement in any direction sets the correcting forces at work. This unit carries two clinometers which show the exact relation in degrees of the aeroplane to the horizontal at all times.

Electric current for these gyros is supplied direct from the driving motor of the aeroplane by a small generator * * * although it can be driven by a small auxiliary motor if desired. The speed is held constant by a special governing device which gears up the generator at low motor speed and runs it by direct drive at flying speeds. This holds the voltage constant at 25 volts from the direct-current winding and 23 volts from the three-phase alternating-current section of the armature. The direct current is used for exciting the field windings of the alternating-current generators, for actuating the magnetic clutches in the stabilizing equipment and for various other purposes about the aeroplane, such as the searchlight. The alternating current drives the gyros. There is also a small storage battery of 3 amp.-hr. at 20 volts to supplement the generator. This normally floats on the generator line, but should the generator for any other reason fail to supply current, the battery switches-in to operate all the direct-current appliances on the aeroplane. An automatic cut-out switch prevents the battery discharging through the generator.

The navigation of the aeroplane is through the universal hand-control lever *D*, Fig. 1, altering the relation between the frame of the aeroplane and



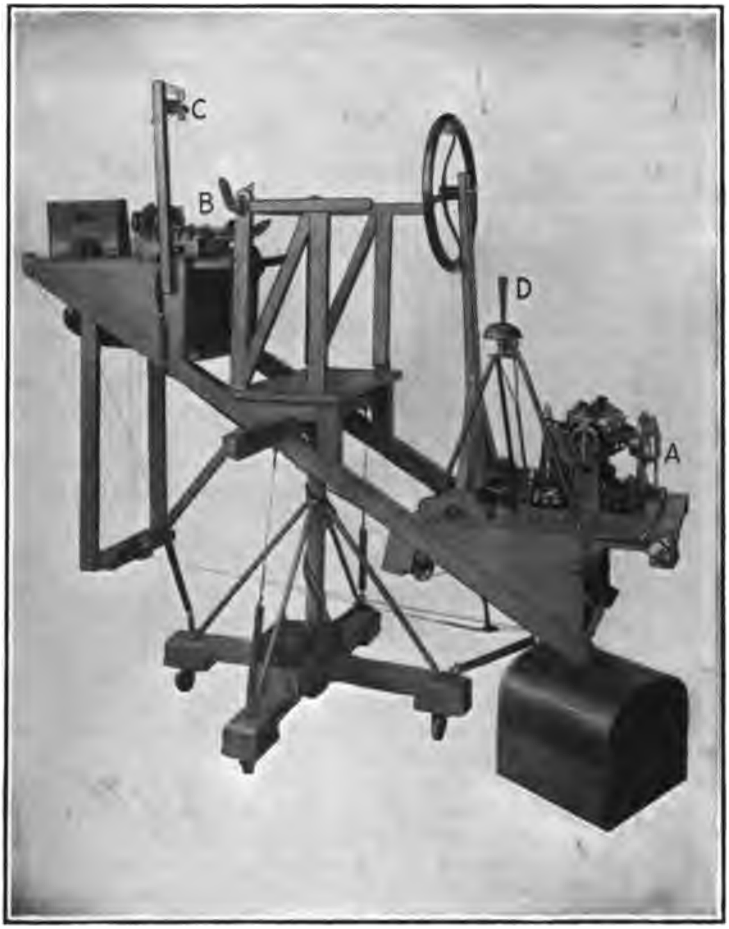
Courtesy of the Sperry Gyroscope Co. 1844

FIG. 1.

GYRO-STABILIZER INSTALLATION IN A CURTISS FLYING BOAT

the plane of the stabilizing unit. This is done by controlling the brushes which bear on the segmental contacts of the gyroscopic unit by means of small wire cables. In starting a flight the hand-control lever is pulled back by the aviator and the segmental contacts are moved from the neutral to an active position. This completes the circuit to the magnetic clutch in the servo-motor *B* and moves the elevating plane in the proper direction, which causes the machine to climb at that angle until the aviator places the hand control in its neutral position. Then the stabilizer takes up the work of keeping it there.

This is accomplished by what is known as the servo-motor, which supplies power for the operation of the aeroplane controls. It is operated by a six-bladed propeller shown at *B*, Fig. 1, power being supplied by the air resistance as the machine flies. The propeller blades are so arranged as to fly outward and change their pitch with an increase in the speed of the aeroplane, thus maintaining the speed of the motor constant. There are four magnetic clutches in the servo-motor, each pair controlling a drum which carries the wires running to the aeroplane controls.



Courtesy of "American Machinist." 1845

FIG. 2.

MODEL FOR TEACHING ACTION OF STABILIZER

Another important device is the anemometer shown at *C*, which is virtually a single-pole, double-throw switch controlled by a fan. It is normally held in one position, so that as long as the speed is sufficient to maintain flight it does not act.

Making an Automatic Landing

Should the speed decrease as a result of the motor's stopping or for some other reason, the switch is thrown to a safe angle and the machine volplanes to the earth. When sufficient speed is attained, the switch throws over and the segmental contacts bring the machine back to normal. In the case of a disabled motor this will bring the machine to land or water in a series of volplanes and make a good landing if the space is clear of obstructions.

Aeroplanes now have very similar equipment to a steamship—a compass for direction, having a luminous dial for night use, and a small electric light for twilight, before it is dark enough to see the luminous markings. Then there is a drift indicator, which shows how much the aeroplane is being carried sideways by the wind. A telescope capable of being stabilized by gyroscopes at any desired angle relative to the horizontal has also been developed for military purposes.

The arrangement of these instruments can be seen in Fig. 2, which illustrates a demonstration machine built for the instruction of students in the handling of this apparatus, the framework representing a Curtiss aeroplane having the instruments in the proper position. The framework is pivoted at the top and held in position by the four coil springs shown. With the gyroscope in motion, any movement of the control throws the framework out of equilibrium and shows how it is at once brought back at the action of the spirals. To avoid confusion the parts are lettered to correspond with Fig. 1.—*American Machinist.*

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BOMB THROWING FROM AIRCRAFT

Aeroplanes and airships have often brought about severe damage in the present war by bomb throwing, in spite of the fact that the difficulties of hitting a definite target from rapidly moving aircraft are considerably greater than from guns standing fast on the earth. The reason for this is primarily that a bomb thrown from a flying machine does not fall vertically but continues to move in the direction of the machine, so that the bomb must be thrown a definite time before reaching the target in question. Special sighting arrangements for the determination of this time forms part of the equipment of aircraft.

But before describing such arrangements we will first investigate the trajectories described in the air by the thrown bombs.

It is well known that if an object, for instance a stone, be dropped from the window of a moving train, it will strike the foot-board at a point vertically underneath the hand. But since the train has been moving forward while the stone has been falling, the latter will strike the foot-board at a point over the earth in advance of where the stone was released. If, instead of dropping the stone on the foot-board, it be dropped directly on the earth, it will likewise reach the latter at a later point than that over which it was released. The stone in falling has covered the same path as the moving train.

The trajectory of a bomb dropped from a moving aircraft is formed in a similar manner. Such a bomb is under the influence of two forces: one the forward movement of the aircraft, and the other the attraction of gravity. Under the influence of the resultant of these two forces the bomb describes a curved path from machine to the earth, in fact, a parabola if air resistance be neglected. Fig. 1 shows the path *p* of a flying bomb from machine *A* to target *B* under the assumption that the aircraft moves with uniform velocity in a horizontal direction above the target. At the instant that the bomb strikes the target *B* the machine is at *C*, vertically above *B*. The parabolic path results from the fact that only the horizontal velocity of the object thrown remains uniform, while the velocity in a vertical direction varies as the square of the time, for as is well known a falling body travels about 5 meters during the first second, in two seconds 2×2×5 =20 meters, in three seconds 3×3×5=45 meters, etc.

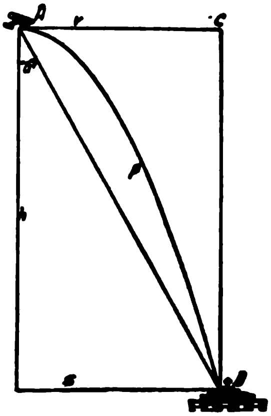

FIG. 1. 1846

If, for example, the aircraft is moving with a velocity of $v=40$ m. per second at a height $h=1000$ m., the distance *s* by which the bomb must be thrown in advance of the target results from the following consideration.

A body falling from a height of 1000 m. requires about 14 seconds to strike since 14×14×5=1000 m. The bomb must, therefore, be hurled 14 seconds before the aircraft reaches point *C* vertically over the target to be hit; in other words, the bomb must be thrown when the machine is over a point 40×14=560 m. in front of the target.

It is generally more convenient to determine the instant of dropping the bomb by means of the sighting angles than by calculating the distance *s* from the target, since in this case it is not necessary to observe a second fixed point on the earth. The bomb is then released when the target becomes visible to the eye of the observer under the previously determined angle $a_1=29°$ as is also shown on Fig. 1. As is readily seen, the distance in front of the target at which the bomb must be released increases with increase of height and increase of velocity of machine. In case the bomb is released only ½ second too soon or too late, it will strike 20 meters in front or behind the target. Airships have a better chance of hitting their targets than aeroplanes since they are in a position to reduce their speed at will or even to stand still when dropping bombs, provided they are not prevented by hostile aircraft and balloon defense guns. By standing still, airships can throw a number of bombs on the same target, whereas aeroplanes must always take a new aim with every shot. The parabolic curve becomes more nearly vertical as the velocity of the aircraft diminishes becoming vertical when at rest. In this case the throwing angle a_1 becomes zero.

The uncertainty of hitting a target is still further increased by the fact that the object thrown travels through air and the trajectory does not, therefore, coincide exactly with a parabola, although the errors caused by air resistance can be suitably corrected on the basis of experiments. The effect of air resistance can also be diminished by giving bombs a suitable exterior form.

An importance influence on the trajectory is caused by the wind. This causes an increase or decrease on the distance s depending on whether the bomb is thrown with or against the wind, while a side wind carries the bomb out of its trajectory plane. In addition, it often happens that the velocity and direction of the wind vary at different heights and that the trajectory consequently takes a different shape from that calculated, even when consideration is given to wind conditions in the immediate vicinity of the aircraft.

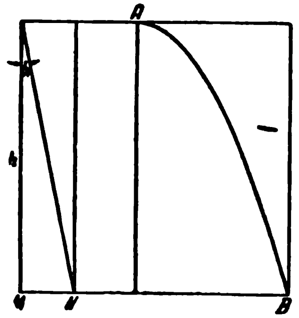

FIG. 2.

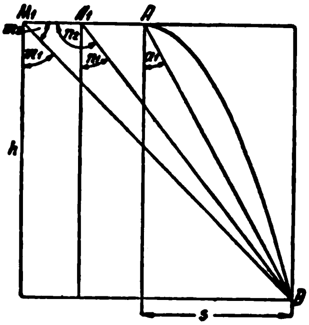

FIG. 3.

1847

But even if it were possible to release the bomb at the determined time and to eliminate air and wind resistances, accuracy still depends upon corrections of height and velocity of machine from which the throwing angle is calculated.

For determination of the height, a barometer is employed giving fairly reliable results. From the heights determined with this instrument, the elevation of the target above sea level, which is taken off the map if not otherwise known to the observer, must be deducted.

The determination of the velocity of the aircraft at the moment the bomb is released is more difficult. It can be ascertained by the time required to cover a definite distance lying in advance of the target. If, for example, the bomb is to be thrown from *A* on target *B* (Fig. 2), then the time at which the machine passes over an object, such as a tower, house, or tree, *M*, is observed, and again the time at which it passes over an object *N* on the earth. By taking from the map the distance *MN* and the time of flight required to cover this distance, we are enabled to determine the velocity of the machine shortly before releasing the bomb. If, for example, the distance *MN* be 200 meters and the time required to cover same be 5 seconds, then the machine has an average velocity of $200 \div 5 = 40$ meters per second. The velocity of the machine may also be determined by observation of the angle of sight. In this case the distance from M to N need not be known. Preferably the angle b_1 at which the object N is visible to the observer at the instant of flying over M is determined and the time required for the machine to pass vertically over N observed.

It is not even necessary to sight upon an object on the earth in advance of the target, since the velocity of the machine can be determined by sighting directly upon the target itself as shown in Fig. 3.

In this case the observation instrument is set for a definite angle m_1, and the time noted at which the target, upon which the bomb is to be thrown, comes into view under the angle m_1. The instrument is now set for an angle n_1, which must be less than m_1, and the time again noted at which the target appears under the angle n_1. From the number of seconds required for the machine to travel through the angles m_1 and n_1, and from the height of fall h, the velocity of the machine over the distance M_1N_1 can be determined. The length of M_1N_1 is arrived at from the triangle M_1N_1B three of whose parts are known: height h and angles m_2 and n_2; angle m_2 being equal to $90° - m_1$, and angle $n_2 = 90° + n_1$. The quotient of the distance M_1N_1 in meters divided by the time of flight in seconds again gives the average velocity of the machine in meters per second. From the velocity so determined and from the height of flight, the angle a_1 at which the bomb must be thrown can be calculated.

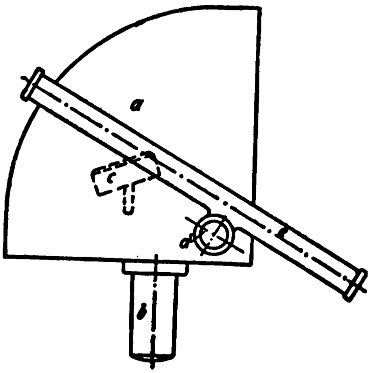

FIG. 4.

Fig. 4 shows a sighting arrangement which permits of setting the three angles m_1, n_1, and a_1 shown in Fig. 3. The arrangement consists of a frame *a* whose sides have the form of a quadrant. On the under side of the frame is a pivot *b* by means of which the frame can be set up on a vertical tube of the machine or other suitable opening. To the rear side wall of the frame is attached a clock *c* while the front wall has a pivot *d* upon which turns a telescope *e*. The center of the pivot is also the center of the angular arc. This arc is graduated by scales from which the line of sight of the telescope is read. The lower position of the scale serves for setting the height of flight and the upper part for setting the seconds. The angle of sight n_1 is most suitably set at a definite mark on the scale and, therefore, remains always the same.

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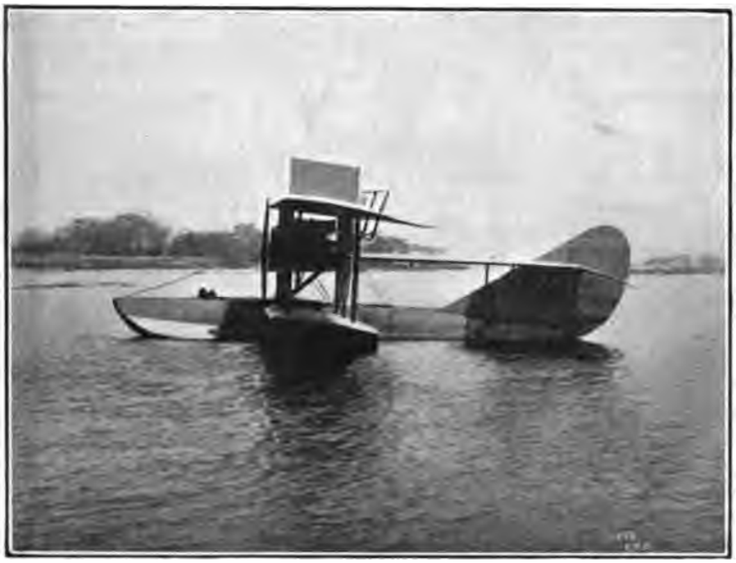
an hour. The craft was held out of a consignment for the British, and delivered to the Coast Guard with the personal compliments of the manufacturer, Glenn H. Curtiss.



Aerial Age Weekly. 1850

Fig. 2.

A heavy wireless equipment is to be installed with the idea that the boat shall be used as a scout to locate derelicts and either blow them up or stand by, even in a rough sea, while the wireless summons a cutter.

For war purposes, it can be equipped with guns of large enough caliber to enable it to destroy submarines; and, for general cruising duties, it can displace three cruisers and do their work faster and better with only three or four men, affording a saving of millions of dollars.

—From *Aerial Age Weekly* and *Flying*.

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SUPER-ZEPPELINS

By Baron Ladislas d'Orcy, Member, American Institute of Aeronautic Engineers

It is common knowledge, that for some time past a new type of Zeppelin, far more powerful than any of its predecessors, has been commissioned with the Air Service of the German Navy. The recent destruction, by the agency of the Allies' anti-aircraft artillery, of two of these vessels has now afforded the long-sought opportunity for getting a closer view of this type of aircraft—which for sake of convenience we shall term a super-Zeppelin.

A layman might hardly discern any change in the outward appearance of a super-Zeppelin, when compared with previous types; it appears, however, upon examination of what remained of the vessels destroyed at Révigny (the LZ-77) and in the mouth of the Thames (the L-15), that the hull, steering organs and propelling apparatus have been re-designed to a great extent on the latest types.

It is a matter of discussion whether there exists but one new type or whether the Zeppelin Works still turn out a large long-range type for naval raids and one, smaller but faster, for military reconnaissances. The fact remains, however, that the Germans possess at present a large type of Zeppelin whose features, as far as they are known, shall be discussed herewith.

THE HULL

The hull of the *ante-bellum* Zeppelins was in the shape of a cylinder with two symmetric ogival ends—a very poor form, aerodynamically speaking; and it was still made worse by an exaggerated aspect ratio of ten to one, which comes to say that the hull was ten diameters long.

On the super-Zeppelin this defect has been remedied to some extent. The bow is slightly blunter than before, while the stern is nearly conical; furthermore the aspect ratio has been somewhat decreased, so that now the hull is only about eight or nine diameters long. Although this ratio is still some way off the one disclosed by aerodynamic research work to effect the smoothest airflow (6:1), it must materially assist the super-Zeppelin in attaining a greater speed without the expenditure of additional power.

Regarding the size of super-Zeppelins, an examination of the wreck of the LZ-77 reveals that this vessel (which undoubtedly belonged to a recent type, as is disclosed by her factory number) was about 540 feet long, with a displacement of over 1,100,000 cubic feet which would furnish a lift of about 33 tons.

THE STEERING ORGANS

The steering organs have been greatly simplified on the super-Zeppelin.

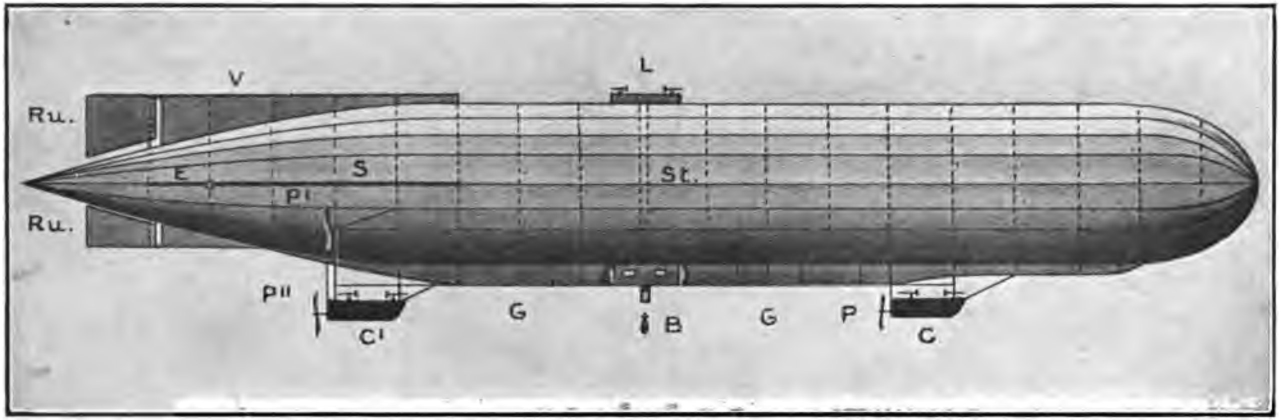
A picture of the L-15 (which was photographed before she broke up and sank) shows clearly, that in place of a large number of small and parallel rudders and elevators, there is now a compact *empennage*, very similar to that of a tractor aeroplane. Both rudder and elevator now consist of simple "flaps" which are hinged to the vertical and horizontal fins, respectively. Their surface area has naturally increased, as the conical stern takes up less space than when it was blunt; as a consequence and, owing also to a smoother air-flow, the efficiency of the steering organs should have materially increased.

THE PROPELLING APPARATUS

The distribution of power has been very radically re-designed on the super-Zeppelin, the new system being one that follows marine practice closer than was customary hitherto.

While the 1914-15 type of naval Zeppelin was propelled by two sets of two 200-horsepower engines, each set driving two air-screws mounted on outriggers on either side of the hull, the super-Zeppelin carries but one engine in the front car and three engines in the rear car. Two of the stern engines drive side propellers in the old fashion; but the third one, as well as the front engine each drive a directly coupled propeller at the rear of the cars.

The advantages derived from mounting the propellers astern are manifold. Firstly, as there is nothing to interfere with the air thrown back by



OUTLINE (SIDE VIEW) OF A 30-TON SUPER-ZEPPELIN. DRAWN TO DATA OBTAINED FROM THE WRECKS OF LZ-77 AND L-15 1851

(C C') ENGINE CARS (THE ONE IN FRONT CONTAINING THE PILOT HOUSE); (PP'P'') PROPELLERS; (G) GANGWAY CONNECTING THE CARS AND CONTAINING WATER-BALLAST AND FUEL TANKS; (ST) STAIRWAY LEADING FROM BOMB ROOM (B) TO ARMED LOOKOUT (L); (S) STABILIZING FIN; (E) ELEVATORS; (V) VERTICAL FIN; (RU) RUDDERS the propellers, the efficiency of the latter should be somewhat increased; secondly, the danger of sparks from the exhaust, which might ignite the hydrogen, is rendered very remote; and thirdly, the mounting of the engines in the stern car should afford more room in the front car for the navigating *personnel.*

One might therefore assume that ultimately the stern car will become the sole engine room, while the bow car will be the navigating room and nothing else. If this has not been done yet, it should rather be attributed to a lack of higher powered engines, than to some obscure reason for keeping one propeller ahead.

ARMAMENT

The armament of these vessels has hardly changed. The bomb-room has remained in the middle of the gangway; but the crude way of dropping bombs by hand has been superseded by a scientific appliance, whereby the bombs are released electrically.

In addition to the two machine guns mounted on each car, two more have been provided for arming the lookout post, atop of the hull, which is connected with the bomb-room by means of a stairway encased in a chimney.

* * * * * *

Thus far the apparent changes affecting super-Zeppelins.

Modifications relative to the ratio of dead weight to useful load, are more or less a matter of speculation. On the *ante-bellum* Zeppelins the useful load amounted to about one-fourth of the total lift. According to a statement emanating from Count Zeppelin's secretary, the climbing power of the new type is two-fifths better than on previous types and the load of ammunition amounts to two tons; it might therefore be assumed that the useful load is also at least two-fifths better than heretofore, in which case its ratio would be 35 per cent of the total lift.

Such an improvement is entirely within the present-day possibilities, if one bears in mind that the ratio of dead weight to useful load *decreases* with the Zeppelin's size and that the super-Zeppelins displace about ten tons more than the vessels of the previous type. Some weight may also have been saved through an improved system of construction, as well as by the new 200-horsepower engines which weigh only 880 pounds, instead of 985 pounds.

On the basis of the above ratio a 33-ton super-Zeppelin carries a useful load of about 11½ tons—more than double the load the previous type was capable of lifting. If such is the case, allowance for two tons of ammunition leaves nine and one half tons available for crew, ballast, and fuel.

THE CREW

Of the two super-Zeppelins destroyed lately, the LZ-77 carried 15 men and the L-15, whose crew was captured, two officers and 16 men. Supposing the latter figure represents the war complement of the largest super-Zeppelin, it remains to be computed how these 18 men are detailed for navigating and fighting.

The three-engined passenger Zeppelins required a navigating personnel of nine men, distributed as follows: the commander, two helmsmen and two mechanics in the front car (housing one engine); and a chief engineer and three mechanics in the rear car (housing two engines).

Although a super-Zeppelin mounts a third engine astern, it might be assumed that the engine crew has not been increased, five mechanics and one engineer being quite sufficient for looking after four engines. But in view of the super-Zeppelin's long cruising radius a third helmsman might have been added to the crew; this would leave eight men, including the lieutenant, for manning the bomb tube and the machine guns. Six men are required for manning the latter; the remaining two would then constitute the bomb-crew with the lieutenant as gunnery officer, and possibly, second in charge of navigation.

A complement of 18 officers and men represents a load of about one and one half tons; there would then remain eight tons for ballast and fuel.

THE BALLAST

There are very good reasons for believing that the water-ballast has been considerably increased on the 33-ton airships. Vessels of the previous (23-ton) type, which carried 1½ tons of ballast, used to navigate at an altitude of 5000 feet and hardly ever reached the 9000 feet mark, excepting trials; super-Zeppelins, however, often reach an altitude of 10,000 feet and are currently seen navigating at 7000 feet.

Whereas the buoyancy of a Zeppelin is just sufficient to keep the vessel floating at a low level, great heights can be reached only through a combination of dynamic lift (expenditure of engine power) and of static lift, the latter being attained both through jettisoning ballast and burning fuel, and in extreme cases, by a forced dropping of bombs.

The question of ballast is one closely allied with that of compensating losses of buoyancy at great heights. Lack of space unfortunately forbids a detailed discussion of this subject; suffice it to say, that losses of buoyancy cannot be made up entirely by jettisoning ballast and one might assume that some artifice, possibly a system of compensating balloonets for each of the 20 or more gasbags, has been devised for remedying this defect on super-Zeppelins.

Such a course should not be astonishing at all in view of the several airships the German Navy lost in the North Sea, for the sole reason that when they came down from a great height, the gas, after having expanded, contracted through the greater atmospheric pressure and proved insufficient for insuring the necessary buoyancy. It was this phenomenon which caused the loss of L-3 and L-4, not to speak of others.

Anyhow, one can safely assume that the ballast of a 33-ton vessel is at least double that of the *ante-bellum* Zeppelin, say three tons, but more probably four tons, leaving four tons available for the fuel.

CRUISING RADIUS

As the fuel consumption of the four-engine unit amounts to about 450 pounds per hour, four tons of fuel would keep the engines running for about 18 hours at full speed (55 knots) and thus insure a cruising radius of 990 nautical miles. The latter figure will possibly necessitate a reduction of, say 10 per cent, if allowance be made for the fuel burnt while climbing.

If it were feasible to run the vessel on the homeward journey (after she had been lightened up through the expenditure of fuel, ballast, and bombs), with two engines only, the radius of action might be somewhat increased. By using the formula

$$\text{Speed at x Power} = \frac{\text{Full speed}}{\sqrt{\dfrac{\text{Full speed}}{\text{x speed}}}}$$

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y, and with no limit to the development of material, this the uses of the aeroplane becomes really prodigious. It at artillery fire is regulated, after the airmen have reconotographed the enemy's positions, taken the plan of their iscovered the importance and the emplacement of their from the air that the arrival of reinforcements by rail or gnalled. By means of aerial bombardments attempts are r at least disorganize, the enemy's communications. These made even on the base railway stations, and, further still, s and powder magazines whence come the munitions. During aeroplane flies above the troops and regulates the lengthening the assaulting forces advance. In addition it is necessary to astery of the air by preventing the adversary from doing the rselves in the air, and protecting our own machines from the s fighting machines we have the chasing aeroplane and the aser, which attack and defend the working aeroplanes and the lloons which watch and act as police day and night over towns pal centers of production, protecting them from enemy aeroplanes ibles.

ay be said to day that flying is the most complicated arm, and the inite in its applications, as it combines in itself the doctrines, the nd the resources of all the arms which fight on land. Add to this ization at sea, and you will have some idea of the diversity of the ary uses of the aeroplane in warfare. I insist on this word necessary, e aeroplane gives to those who know how to make use of it such a riority that none of its resources can be neglected, and every possible cation soon becomes an indispensable application.

FOUR PRINCIPAL CLASSES

Constructors first thought of building an almost unique type of aeroane, which would serve for all these uses. The advantages of this unication were obvious; greater facility of production, of repair, and of apprenticeship. Unfortunately it was a Utopian idea, and had to be abandoned. Just as is it impossible to have one single type of ship, and it has been found necessary to create different types for different functions, necessitating specific qualities of speed, tonnage, armament, and defense, so it has been found necessary to create different types of aeroplanes.

Certain of the functions which I have just enumerated demand, in fact, qualities which not only differ, but are opposed to each other, and practically exclude one another. Thus, the ideal apparatus for regulating artillery fire would be one capable of perfect immobility above the points to be observed. A "chaser," on the contrary, calls for the greatest possible speed. Now, in aviation, the lowest speed without falling is always in relation to the greatest speed—it is roughly equivalent to 50 per cent of the maximum speed. The incompatibility of these two solutions is apparent. In the same way, a "bomb-dropper" must above all be a weight lifter, a quality entailing considerable wing surface, and consequently low speed and a certain difficulty in maneuvering.

On the other hand, it was impossible to increase to infinity the types of machines, because we have neither an infinity of models nor of motors, and the qualities of an aeroplane are first of all determined by the power and weight of its motor. A compromise was therefore arrived at by the selection of four principal types of aeroplanes, which are, according to their uses—(1) scouting aeroplanes; (2) artillery observation aeroplanes; (3) bomb-droppers; (4) battleplanes. Each of these types is divided into sub-types, ranging from what may be called the minimum of utilization to the maximum of utilization.

SCOUTS

They are employed for the examination of the enemy sector, first by the eye of the observer, and afterwards by means of photography. At the beginning of the war these aeroplanes were obliged to have a large sphere of action. With trench warfare this range of action has been much reduced. It is therefore not necessary for them to carry much petrol. Their principal qualities are: great maneuvering facility, in order to escape from enemy artillery fire, and great climbing power, to escape from enemy chasers, for, considering the essential irregularity of their missions, it is almost impossible to supply them with convoys of fighting planes to protect them. They should have on board a camera with special lens, a machine gun able to fire in all directions for self-protection, and, finally, a wireless installation, specially useful in signaling the advance of troops during important battles. The scouting aeroplane is the least specialized of all machines. It is the machine which requires the greatest number of average qualities and especially great facilities for starting from and landing on all kinds of ground. Biplanes of about 43 feet spread of wing, with motors of from 80 to 150 horse-power, are employed in this work.

ARTILLERY DIRECTION

The ideal instrument for directing artillery fire would be a kite which could be sent up and brought down at will, and would remain motionless above the enemy target. The apparatus must be able to fly slowly and permit the observer to look in all directions, for it is not a question of taking photographs. The observer must be able to tell where every shell falls, and by wireless immediately regulate the fire of the battery. At the same time he must escape the enemy's artillery fire and the attacks of chasers—attacks rendered all the easier by the fact that the artillery observation plane does not leave its sector, and the enemy knows where to find it. The apparatus should therefore be light, small, able to climb rapidly, a good air-craft in all winds, with an observer enjoying the utmost freedom. Consequently use should be made of small biplanes with a wing spread of about 30 feet, furnished with two light and powerful rotary motors. The observation seat might be slightly protected, but it is needless to over-arm the apparatus. The artillery officer has no time to see whether he is about to be attacked. He passes slowly and continuously over the target he is surveying. On the other hand, as his itinerary is fixed, nothing is easier than to protect him by means of a chaser, turning above him and dominating in advance the adversary bent on attacking him.

BOMB-DROPPERS

The bomb-dropper is the dreadnought of the air. At the same time one must not be mislead by the apparent ease of indefinitely increasing [illegible]. There comes a moment when the degree of usefulness decreases rtion to the increase in power. This is where a halt must be t is better to distribute the same weight of bombs over a greater number of machines, for by so doing we obtain greater security, augment the accuracy and rapidity of the bomb-dropping, and add to the chances of escape from the enemy. The bomb-dropping aeroplane must include among its qualities a certain minimum of speed, climbing power, and maneuvering capacity to enable it to escape from the fire of anti-air guns. As for chasers, bomb-droppers must not be expected to defend themselves against these. They must be escorted by squadrons which have nothing else to do, composed of machines in which the weight carried does not consist of bombs, but of guns and munitions. Bombarding fleets always include several squadrons, operating on well-determined itineraries, known in advance, at fixed hours. Thus, convoying them is easy. It has been found possible to group in this way 50 machines, which, flying in a triangle like wild duck, have gone as far as the large cities of South Germany—Stuttgart, Karlsruhe, and Mannheim.

These machines must therefore have very powerful motors—200 horsepower—a large range of action, and large fuselage, permitting the well-aimed dropping of bombs of special apparatus. They should also carry a machine gun. This is the most difficult machine to construct, and the task of he who pilots it is both ungrateful and perilous—long raids over enemy territory.

THE BATTLE-PLANE

This is the latest product of military aviation, and it is easy to understand why. In aerial warfare one first of all attempts to make use of one's own aeroplanes. After that one tries to prevent the enemy from doing the same. This gave rise to the creation of the "chaser," a light aeroplane, rapid, and climbing very quickly, so as to dominate the adversary—a favorable position in aerial combat. Finally came counter-chasers, whose object is to defend working aeroplanes—that is scouting planes, artillery directing planes, and bomb-droppers—against enemy chasers. These aeroplanes are of the same type as chasers, simply rendered more redoubtable by their armament.

Aeroplanes of the fighting type cannot be large, a condition which limits their artillery and its caliber. Most of them do not exceed a ton in weight. They are the only single-seated type. The pilot is at the same time the gunner. A two-seated apparatus would be preferable. The smaller the machine the better provided it can carry a sufficient armament and is built in such a way as to permit firing in every direction.

There are two schools: those who are in favor of placing the propeller in front, which augments the speed, but does not allow the use of the forward machine gun; and those of the propeller in the rear, which means a slower machine, but more accurate firing. The first school has triumphed, for it is easier to improve the firing than to do without great speed, which alone makes chasing possible. The necessity of making warfare on balloons, Drachen ("sausages") and Zeppelins has led to the creation of gun-planes, and for fighting Zeppelins at night less rapid machines have been built. They land in the dark with less danger. Armed scouting machines are used for this purpose. The questions of aeroplane armament and of aeroplanes intended for night flights merit special study.

LIMIT OF DIMENSIONS

It only remains to draw the logical conclusion on the subject of the size of aeroplanes. The largest aeroplane and the most powerful is the bomb-dropper. The smallest is the chaser. The practical limits of construction, minima and maxima, will therefore be obtained from the two following considerations drawn from their two special applications: An aeroplane is too small when it does not even permit a machine gun to be carried; an aeroplane becomes too large when its increase in power and surface is not accompanied by a proportionate increase in weight-lifting capacity.

The materials employed in construction are not capable of indefinite improvement. There comes a moment in a large apparatus when they are no longer capable of supporting the pressure and resistance consequent on the increased mass. At this critical moment one of two things happens. On the one hand there may be either a reduction in the factor of safety—which is in general six; that is to say, each part of the aeroplane ought to be able to support during the static test six times the normal pressure in regular flight. Then the apparatus becomes dangerous. On the other hand the structure may be modified and strengthened, when the apparatus becomes heavier, that is to say, it carries less useful weight. Besides, it is impossible to pilot it, for it is too heavy and does not answer the rudder.

This is why no giant apparatus exists made from available materials. It is only the operation of a natural law; giant animals are gradually disappearing. Motor cars have never exceeded a certain weight. Aeroplanes will never, practically, go beyond certain dimensions so long as they depend on the same laws of flight, with motors of the same weight, in proportion to their power.—From *London Times* in *Proceedings U. S. Naval Institute.*

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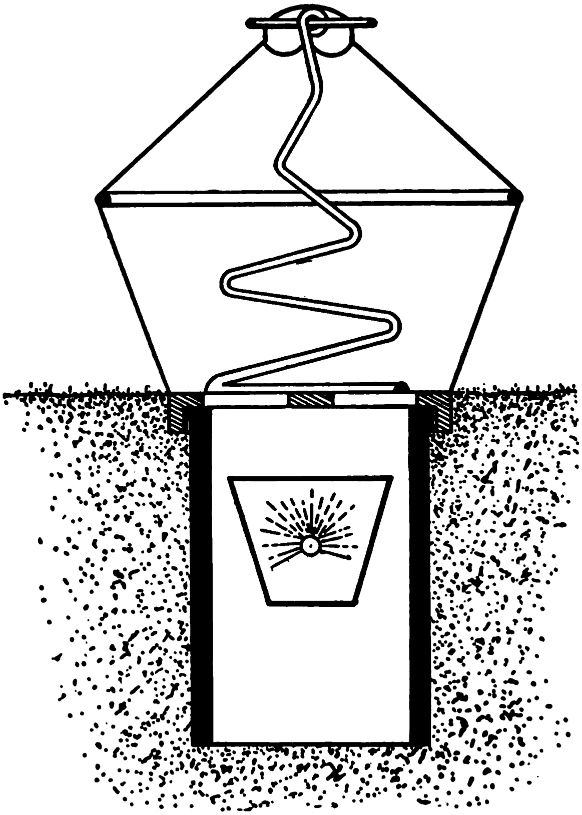
NEW AVIATION BEACONS THAT MAKE SAFE THE LANDING OF AIRCRAFT AT NIGHT

By Robert G. Skerrett

The Germans have lately evolved a type of lantern for aviation fields and other landing places which removes a number of the dangers to which the air pilot has heretofore been exposed in returning to earth at night. As may easily be appreciated, the proper lighting of aviation stations is confronted with a number of difficulties. Logically, it is undesirable to support the beacons on poles or towers, because the exact height of these can not be accurately judged after dark, and they are obstructions against which the airman may unwittingly strike. Further, the lights are proportionately blinding as their power of illumination is increased, and to the approaching pilot there is a zone of glare which screens the underlying ground, leaving him to hope that all is clear below.

In consequence, the aviator has had to use these navigational beacons with some reservations, and as a broad rule he has found it safest to steer wide of them in descending and really to make his landing somewhere in the neighboring darkened area. As a result, many accidents have occurred, and not a few of them, because of adventitious obstacles in the way of wagons, horses, and other bodies that have been left heedlessly or allowed to stray upon the grounds. The new beacon very effectually obviates the previous handicaps and is designed as a target, so to speak, at which the aviator can aim directly when making his landing, and should he hit any exposed part of the apparatus no damage will be done either to the aircraft or to the lantern.

The light itself, backed by a suitable reflector casting the rays upward, is placed in a pit lined with firebrick. The latter is made in the form of an open-ended cylinder and is sunk with its upper end flush with the ground. Over this opening is placed a stout iron grating through which the light can pass skyward; and upon this grid is set a wire frame covered with a stout gauze which has the property of diffusing the light projected against it, and, at a short distance, appearing in the dark like a luminous globe.



Cross-Sectional View of One of the New German Aviation Beacons 1852

The shade is held up by a spiral spring which collapses when a blow or weight is sustained by the screen. The character of the light is such that it produces an even glow and does not cast misleading shadows or occasion the equally deceptive reflections that are so common where a bare light is concerned. These lamps or beacons are placed upon the aviation field at regular intervals and spaced from 22 to 54 yards apart, depending upon the area of the landing space and the nature of the illuminant. The lamps may be electric, oil, or gas.

The shades have a maximum diameter of something like 18 inches and a total height of about a foot so that they lie low and distribute the light very evenly upon the surrounding ground. More than this, they can not be hit except by the landing wheels of the flying machine. They crush easily under such a blow, and straighten up again immediately afterwards. The grating over the pit is strong enough to support the weight of a passing wheel and its load, no matter how large the aircraft.

—*Scientific American.*

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GERMAN SUBMERSIBLE BLOCKADE RUNNER *DEUTSCHLAND*

Construction and Interior Arrangement of the First U-Boat Merchantman

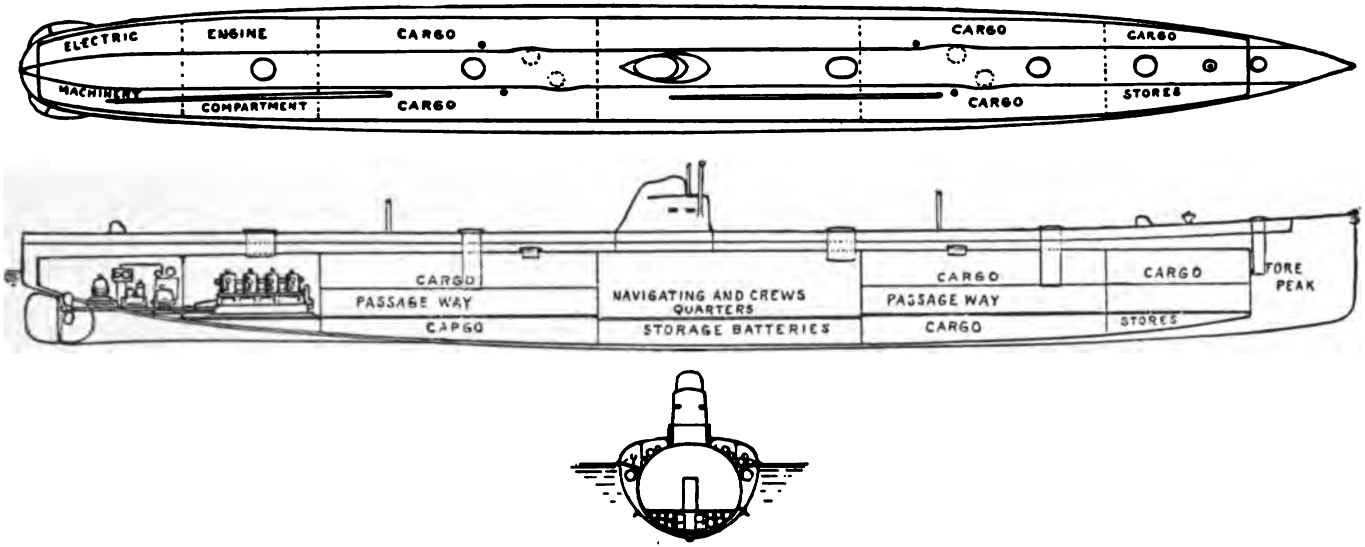
Some few months ago, it occurred to some enterprising men in German shipping circles that if a large U-boat were constructed for the purpose of carrying cargo of unusually valuable character, it would be possible for such a boat to run the gauntlet of the British blockade and deliver her freight in some port of the United States with profit to her owners.

Judged from the standpoint of the naval architect and engineer, the construction of a boat capable of fulfilling the above conditions was a simple matter; even though it is true that in the military submarine, the extra weight which can be taken aboard is measured rather in pounds than in tons. Thus, several tons of cargo capacity would be gained by the elimination of the eight to a dozen torpedoes carried on the largest U-boats. Additional tons would be saved by the elimination of the rapid-fire guns for surface work and their ammunition supply. A further gain could be made by adopting a moderate speed, both for surface and submerged propulsion. The saving of weight in the smaller oil engines, smaller motors, and particularly in the reduced size of the batteries, would represent a very large addition to cargo capacity.

Evidently the thing could be done; and with characteristic enterprise a company was formed in Bremen and several large cargo-carrying U-boats were laid down. The first of these, the *Deutschland*, left Bremen with a cargo of dyestuffs and chemicals on June 14th, and shaped her course for Heligoland. There, she remained for nine days, for the purpose, so her captain stated, of throwing the enemy off the scent, if, by any means, he should have learned of what was being attempted. *Deutschland* was manned by a crew of eight officers and twenty-one men. She was under the command of Captain Koenig.

Because of the dangers of the passage by way of the English Channel, which is netted and heavily patrolled, Captain Koenig laid his course around the north of Scotland, and it was while he was in the North Sea that most of the submergence of the *Deutschland* (ninety miles in all) took place. Normally, the *Deutschland* would travel at the surface; but immediately on sighting any ship or ships that looked suspiciously like an enemy, the boat would submerge and run with only its periscopes above the surface; and if the situation became too risky even for periscopic observation, the *Deutschland* would be carried down entirely out of sight. According to the captain's account, on one occasion the boat was submerged to the bottom, and (in U-boat phraseology) went to sleep for several hours.

As will be seen from our frontispiece and drawings, the *Deutschland* conforms rather closely to the typical German naval U-boat. The hull



PLAN AND SECTIONAL VIEWS SHOWING INTERIOR SUBDIVISION OF BOAT

1853

proper consists of an internal, cigar-shaped, cylindrical structure, which extends from stern to stern, and in its largest diameter measures about twenty feet. Enclosing this hull is a lighter false hull, which is perforated, to permit the entrance and exit of the seawater, and is so shaped as to give the submarine a fairly good ship model for driving at high speed on the surface and at a much lesser speed submerged. The upper portion of the false hull does not present such a flat deck-like appearance as is noticeable in the naval U-boats. In fact, the whole modeling of the *Deutschland*, as compared with the naval boats, suggests that she has been fulled out somewhat, with a view to obtaining the necessary displacement for cargo carrying.

The interior cylindrical hull is divided by four transverse bulkheads into five separate water-tight compartments. Compartment No. 1, at the bow, contains the anchor cables and electric winches for handling the anchor; also general ship stores, and a certain amount of cargo. Compartment No. 2 is given up entirely to cargo. Compartment No. 3, which is considerably larger than any of the others, contains the living quarters of the officers and crew. At the after end of this compartment, and communicating with it, is the conning tower. Compartment No. 4 is given up entirely to cargo. Compartment No. 5 contains the propelling machinery, consisting of two heavy oil engines and two electric motors. The storage batteries are carried in the bottom of the boat, below the living compartment. For purposes of communication, a gangway, 2 feet 6 inches wide by 6 feet high, is built through each cargo compartment, thus rendering it possible for the crew to pass entirely from one end of the boat to the other.

The length of the *Deutschland* is about 315 feet; beam 30 feet, and draught 17 feet. For surface propulsion and for charging the batteries, the boat carries two 4-cylinder, Diesel, heavy-oil motors of about 600 horsepower each. The speed at the surface is from 12 to 13 knots; and submerged, it is 7 knots. At the surface the displacement of the boat is about 2000 tons, and she has a cargo capacity of about 700 tons.

The freeboard to the main deck, which runs the full length of the boat, but is only about 5½ feet wide, is about 6 feet, and the cockpit at the top of the conning tower is about 15 feet above the water. This cockpit, by the way, is suggestive of the protection afforded a chauffeur in an automobile, there being a shield in front of the quartermaster, so shaped as to throw the wind and spray upwards and clear of his face.

Two periscopes are provided; one at the forward end of the conning tower, and the other, of larger diameter, being forward and on the starboard of the conning tower. An interesting feature is the two folding, steel, wireless masts, about 50 feet in height, both of which fold aft into pockets built in the deck of the ship. The forward one of these masts carries a crowsnest for the lookout.

The *Deutschland* passed safely through the dangers of the North Sea, and once clear of the region of British patrols, she remained on the surface and made the trip across the Atlantic entirely at the surface. The weather was fair throughout. She submerged off the Virginia capes for a couple of hours, because of two ships of doubtful appearance. Once inside the capes, however, she made the trip to Baltimore entirely at the surface. She passed the capes on Sunday morning, July 9th, at 1 o'clock, and as she sailed from Heligoland on June 23rd, the time for the whole trip was 16 days. The total distance from Bremen to Baltimore over the course sailed was 3800 miles. That the trip should have been made in that time and without the slightest mishap is a high tribute to the excellence of German naval U-boat and engine construction, and to the seamanship of her skipper and crew.—*Scientific American.*

Short Notes

Modern Fortifications.—That fortifications are still a gigantic factor in the science of warfare will, in the opinion of military experts, be proved if the Allies attempt to capture the German fortifications, particularly the coast defense forts, where are mounted 15- and 17-inch guns behind ramparts designed to resist projectiles from 12- and 13-inch naval artillery.

The latest type of German fortification appears very much like a huge tortoise, lying prone upon the ground. The heavy steel dome which protects the entire battery is curved to prevent the impact of gunfire at an acute angle, and it can be rotated around its axis by electric power. The rifles within the dome are mounted like naval guns, and the entire operation of serving and loading the pieces savors of a battleship rather than a fort. The sighting and loading mechanism of the guns and the rotating machinery of the barbette complete the contents of the turtle-like structure. The ammunition magazine and hoist, the engines for supplying power, and the living quarters of the gun crews are situated in concrete vaults sunk in the earth below the barbette.

One of the novel ideas incorporated in the construction of this type of fortification is that the guns are not turned of themselves, as is usual in land forts, but the entire barbette is revolved until the guns are on a line with the target. Then the guns are raised or lowered, according to the range specified. Here, again, is a striking innovation. Instead of having long, narrow slits which would permit of the guns being elevated or depressed, but which would at the same time admit of the easy entrance of shrapnel, the guns themselves are laid in embrasures and the breeches are moved up and down. Thus the desired effect is obtained without danger to the gun crews.

The heavily protected steel dome, designed to deflect the largest of modern projectiles, and the fact that forts of this nature make use of high-angle fire when attacking battleships would of necessity have to use direct fire, render these fortifications impregnable to naval attacks. It is the opinion of military experts that a hostile fleet could be easily sunk by the guns of these forts before it could inflict any material damage.

Probably the most formidable of the German forts of this nature is that which guards the entrance to the Kiel Canal, where is gathered the entire German surface fleet. This fortress contains a mortar battery, mounting 11- and 16-inch pieces, capable of sending tons of projectiles smashing through the decks of battleships eight miles away. The direct-fire batteries are placed above this battery in tiers, the topmost tier being 176 feet above sea level. In these tiers the heavier pieces are placed below, and range in caliber from 13.9 to 17.7 inches. The lighter ordnance in the upper tiers consists of 8.2-, 9.4-, 10.2-, and 11-inch rifles.

—From *N. Y. Times Magazine* in *Proceedings U. S. Naval Institute.*

BOOK REVIEWS

The Neutrality of the United States in Relation to the British and German Empires. By J. Shield Nicholson. New York: Macmillan Co., 66 Fifth Ave.; and London: St. Martins' Street. 5½" x 8½". 92 pp. Paper. 1915. Price, 6*d.*

This little book is essentially a study of the relation of the United States to the balance of power in Europe with special reference to the war now raging. What is the duty of the United States when a strong nation threatens the balance of power, or in other words threatens to conquer its neighbors? The author concedes that those who are responsible for the foreign policy of the United States should serve the interests of their country. No other country or nation or order of men may take first place in their regard. But there are apparent or immediate interests on the one hand and real or remote interests on the other. It is the apparant and immediate interest of the United States to avoid bloodshed. It is to her real interest to be in an orderly world where the small nations shall be immune from attack. It is also to her real interest that no nation with an overgrown military power, such as that of Germany, should acquire the control of the sea. This is a *sine qua non* for her continued existence as an independent nation; for if the command of the land and the command of the sea should pass into the hands of a single nation, the world dominion of that nation would be unquestioned and unquestionable for many generations.

To avert such a calamity the European nations have a system of balance of power whereby the several nations join in a league for mutual aid when one of their number is attacked by an ambitious neighbor. They join this league for purely selfish and self-regarding reasons, just as individuals join any mutual aid association. So long as the league is capable of restraining their ambitious neighbors, it is hard to see that the United States should be called upon to forego her traditional policy of exclusiveness.

But let us suppose that the league is being overcome by a powerful nation. When would the real interest of the United States become her immediate interest and call for her to lay aside her neutrality? This is the central theme of the book under review. Beyond this point it is not proper for us to discuss the question; but it may be remarked that American sympathies have gone hand in hand with the nation's real interest.

The author effectually disposes of several fallacies that taint the works of many writers upon international politics. He shows, for instance, that commercial rivalry is not the cause of great wars. As a cause of the present war the German menace to British trade was as nothing; but the German menace to the British Empire was everything. Nor are the foreign policies of nations guided mainly by commercial interests. He heartily approves of Adam Smith's passionate attack against "the mean rapacity, the monopolizing spirit of the merchants and manufacturers who neither are nor ought to be the rulers of mankind;" and he fully recognizes that the foreign policy of the United States during the Great War has not been guided by the desires of the manufacturers of munitions of war.

The author discusses his subject fully but briefly and with moderation and restraint.

His book should be read by all those who are interested in the foreign relations of nations.

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Fundamentals of Military Service. By Captain Lincoln C. Andrews, U. S. Cavalry. Philadelphia, Pa.: J. B. Lippincott Co., East Washington Square. 4¾" x 7¼". 428 pp. 19 il. Limp leather. 1916. Price, $1.50.

This book is a timely addition to current military literature and provides interesting and profitable material for the thoughtful consideration of every citizen, but particularly of the citizen soldier.

Recognizing that the march of science and invention has transformed this country into a world power, that this new rôle requires "a degree of military preparedness that will secure us against invasion, and lend forcefulness to the tone when the nation speaks," and that the responsibility rests upon the citizen both for wise legislation and for efficient service, Capt. Andrews points out in his preface that "an honest performance of citizenship demands, first, that each citizen shall learn enough about the military service and its needs to give him an *intelligent opinion* thereon; and second, that each youth shall prepare himself reasonably to meet his individual responsibility as a citizen soldier." And the book is written to further these two ends.

It is of interest to the average citizen principally because of its broad scope. Starting with the Military Policy of the United States, which it is stated with a certain grim humor "has been best expressed in its monetary motto '*in God we trust*'," Captain Andrews sketches roughly the real military history of the country, its unsavory truths, its pointed but unheeded lessons, not in detail, but in such interesting fashion as to impel the reader to undertake the more serious study of this subject.

The several arms of the service, infantry, cavalry, the field and the coast artillery, the engineer and the signal corps, are treated in separate chapters by officers of those branches. Not that any attempt has been made to consider them in detail or to provide a substitute for drill regulations, but the work, powers, capabilities, and limitations of the various services are handled in a fashion to be of interest to the lay reader, giving him a clear comprehension of the parts which they play in the teamwork of the Army.

Continuing to more detailed "Fundamentals," the book outlines the theory and practice of Military Courtesy; the requirements of Guard Duty and the disagreeable but sometimes necessary Riot Duty, dealing in this particular largely with the little understood subject of "mob psychology"; the rudiments and many practical suggestions on Small Arms Firing; Map Reading and valuable hints for self help in route sketching. Several chapters are devoted to Field Service Regulations, amplifying its principles for the benefit of non-technical readers.

No man can read this volume, no matter what may have been his prior knowledge of military matters, without gaining a better and fuller appreciation of what military training really is and how it may be accomplished.

But for the National Guardsman, the book is of much greater value. While special chapters are devoted specifically to the subject, practically every page is a study of military psychology, particularly the art of leading men. Too little attention possibly has been devoted to the training of officers and non-commissioned officers as efficient commanders of companies, platoons, and squads. Captain Andrews, from his wide and varied experience, has outlined the psychological phenomena of successful leadership, in a style convincing and easy of comprehension. Every National Guard officer and non-commissioned officer should be thoroughly familiar with the principles laid down in this section and, if the principles are adhered to, should see his reward in the increased efficiency of his organization.

* * *

Attack and Defense of Fortified Harbors. Second Edition. By Captain Arthur P. S. Hyde, C. A. C. Kansas City, Mo.: Franklin Hudson Publishing Company. 5¼" x 7". 82 pp. il. Cloth. 1916. Price, $0.75.

Recent publications on military subjects include one of unmistakable value to all concerned or interested in the complex problem of coast and harbor defense. This volume, *Attack and Defense of Fortified Harbors*, which is a second edition of an exhaustive treatise on the subject by Captain Arthur P. S. Hyde, C. A. C., U. S. A., is not only particularly interesting and instructive, but may be classified as the last word on this particular branch of the coast artillery subject.

It must be obvious to many who attempt to wade through even a fraction of the great and ever increasing mass of real and alleged literature now confronting the victims of mental military starvation, that it is only at rare intervals when a really helpful book is found. Captain Hyde's work, however, is a volume of unusual instructive excellence and is written in such an engaging manner that it should not fail to have a prominent place in stable military literature.

The book contains a discussion of the general principles of coast defense, including the attack and defense of fortified harbors from the sea, the land front and the air. The subject of the strategic location of permanent works is exhaustively treated with relation to conditions existing here and abroad. The harbors selected for permanent defenses, both in the U. S. and its oversea possessions are indicated. Various methods of naval attack which may be anticipated are carefully analized. The caliber and power of coast defense armament, including the mobile elements thereof receives careful technical treatment. The various stages of combined land and naval attack are carefully studied and attention given to the most minute details of the functions of the various combatant elements.

The appendices contain a lucid correspondence course in question and answer form, also bibliography which can be used as a guide for the further study of the subject, or as an aid to those contemplating the collection of authorities on coast defense. Many interesting illustrations of fortification and armament are inserted throughout the text.

The work is entitled to a place in the library of every coast artilleryman, regular or national guard, and civilians can read it with great benefit, for in no other work has this particular branch of the subject received any- g like the treatment accorded to it by Captain Hyde.

Why Preparedness. The Observations of an American Army Officer in Europe. By Captain H. J. Reilly, F. A., N. G., Ill. Chicago: Daughaday & Co., 608 S. Dearborn St. 6¼" x 9". 398 pp. 50 il. 3 maps. Cloth. 1916. Price, $2.00.

The author, a graduate of West Point and an officer of experience who resigned from the Regular Army in 1913 to engage in journalism, was in Manila when the war broke out. He went directly to Europe and joined the American Ambulance Corps and served with the British, French, and Belgian armies from October, 1914, until February, 1915. He then visited the British and French fronts in company with the president of the Chicago *Tribune*, and spent a month in England, where he observed the process of whipping Kitchener's New Army into shape. In May, 1915, he went to Switzerland and studied the mobilized Swiss army which has preserved that small nation as "an island of peace entirely surrounded by war;" and he discussed preparedness with General Ulrich Wille, commander-in-chief of the Swiss forces. After a short stay in Switzerland, he proceeded to Berlin and joined the field headquarters for the correspondents and military attachés, which was maintained near the general headquarters of the Austro-Hungarian army in the great campaign against Russia in the Summer of 1915. He made two trips to the actual front, one to the Twelfth Corps in front of Novo Alexandria and Ivangorod, and the other to the Sixth Corps at the time of the capture of Brest Litovsk. As German troops were operating with these two corps, he had an opportunity to observe the forces of both of the great Central Powers in an agressive campaign. He returned to the United States in the latter part of September.

Thus it will be seen that Captain Reilly's opportunities for observation have been almost unrivalled. He is, as General Wood remarks in an introduction to the work, "a capable, skilled, and critical observer." As a member of the American Ambulance Corps, he was not only a spectator but was also an actual participant in the war, which gives an added value to his book. His narrative and discussion are founded on his personal experiences and the accounts of other participants engaged in the actual fighting whom he considered competent eye-witnesses.

In this book one gets a graphic picture of the vast battlefields that stretch from the North Sea to Switzerland and from the Baltic to the Carpathian mountains. Approaching the fronts, the observer reaches the busy zone just off the edge of the battlefield, beyond the range of the enemy's artillery, where the manifold activities are carried on whereby the fighting lines are supplied with men, ammunition, arms, food, and other stores, and the wounded are withdrawn from the battlefield. Then comes the zone of "vacant spaces," under the enemy's artillery. This is the region of concealed batteries and hidden approaches to the infantry positions. Next comes the zone under the enemy's infantry fire where it is necessary to keep the communication trenches; and, finally, the advance trenches in immediate contact with the enemy.

In an excellent chapter, the author describes the actual operations of two opposing forces which meet, fight, entrench under fire, advance their lines of trenches by stealth at night, and settle down to trench warfare—sapping, bombing, mining, sniping, and surprise assaults. This chapter is illustrated and made clear by a diagram of a section of the Franco-German lines of trenches.

To an American, Captain Reilly's chapters on "The British Campaign," "Kitchener's New Army," "Conscription Needed in Britain," and "The Military Preparedness of the Swiss" are most interesting and instructive.

As a professional soldier of nearly fourteen years' service, Captain Reilly has effectually laid aside personal prejudice and studied, from the soldier's point of view, the military problems which have special importance to the United States. He possesses a quick nervous style and he has produced a work that is full of meat and interesting to read.

The book is illustrated by a large number of excellent photographs taken by the author and by two good maps and a diagram. There is also a very convenient index.

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Studies in Minor Tactics. Prepared by Department of Military Art, The Army Service Schools. 6" x 9". 230 pp. 12 maps. 1915. Price, $0.50.

This latest edition of *Studies in Minor Tactics* is compiled to satisfy the demand for the edition of 1908 which is out of print. Those who were familiar with the "Studies of 1908" and who have kept track of the progress and high standards of work being done at the Army Service Schools would expect the 1915 edition to be a great improvement over all former editions. In that we are not disappointed. The 1915 edition is not a revision of former editions, although published under the same title. It is an entirely new work, containing new situations and treating the subject along different lines.

The preface states:

"It has been the aim to teach the principles of minor tactics by applying them in a practical way to the handling of small units, varying in size from a patrol to a regiment.

"This has been done by a series of troop leading problems in which the various phases of field operations are set forth and commented upon, orders being given for all the units involved down to the smallest patrol.

"It is believed this book will prove of great value to those officers seeking information as to the practical handling of small units in field operations, and of marked assistance to those preparing themselves for admission to the Army Service Schools."

The text is divided into twelve parts: Parts I to III deal with infantry; Parts IV to VII, with cavalry; and Parts VIII to XII, with field artillery. The studies were prepared by Captain H. B. Fiske, Infantry; Captain Le Roy Eltinge, Cavalry; and Captain E. D. Scott, Field Artillery; each in his own arm.

Part I takes up an infantry regiment and follows its operations through three successive days. The regiment detrains north of Gettysburg, advances on that place, attacks the enemy in position there, pursues, halts for the night establishing outposts, prepares and occupies a defensive position, withdraws from it and retreats. The actions serve to illustrate the troop leading of the regiment and all of its subdivisions, from patrols and security detachments through the companies and battalions to the regimental headquarters, by giving in each case the orders issued by the commanders of these units.

Similarly Part II takes up the conduct of a convoy escorted by a battalion, illustrating the security, police, and defense of such body and incidentally the conduct of an infantry reconnoitering patrol. In Part III the other side of the problem of Part II is considered and the attack of the same convoy is taken up, culminating with "the reconnaissance and attack of an enemy in position."

Part IV takes up the leading of a cavalry patrol, following the patrol from the start early in the evening until about 11:00 A. M. the next day. Parts V and VI illustrate the actions of a squadron in reconnaissance and flank protection of a dismounted force, and in mounted combat against a hostile squadron. Part VII takes up the combat of a regiment of cavalry.

Parts VIII and IX are battery problems with the enemy on the defensive and on the offensive in rencontre engagements. Parts X, XI, and XII are battalion problems illustrating the light artillery battalion in observation, in surprise attack against the flank of a hostile line, and in the dual rôle of the defense of a position and on attack.

Interspersed through the book are a number of sketches showing the positions of the troops at important phases. A map, scale 1" = 1 mile, is supplied with the text but a larger scale map, scale 3" = 1 mile, may be used if desired and may be obtained from the Book Department, Army Service Schools.

To Coast Artillery officers, studying the plans and conduct of small units involved in the operations of coast artillery supports, this book will be found of great assistance.

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An Army of the People. By John McAuley Palmer. New York: G. P. Putnam's Sons, 2 West 45th St. 5¼" x 7½". 158 pp. Cloth. 1916. Price, $1.00.

An Army of the People will be read with ever increasing interest. It lays before the public in most logical form a plan for our National Defense which is very clearly worked out and would seem to be capable of being put into practice. It is believed, however, that the author has underestimated the number of inspector-instructors from the Regular Army necessary for the 1st, 2nd, and 3rd years instruction, as double the number would undoubtedly be required.

Major Palmer's book is so readable and his arguments so clearly stated that it should appeal as strongly to the non-professional as to the professional soldier.

His work should be published broadcast so as to reach not only these classes but the entire youth of our land.

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Handbook of Chemistry and Physics. A ready-reference pocket book of chemical and physical data. Compiled from the most recent authoritative sources. Cleveland, Ohio: The Chemical Rubber Company. 4½" x 6¾". 375 pp. Tables. Cloth. 1915. Price, $2.00.

The purpose of this book is to present in compact and portable form a comparatively comprehensive reference book for use in the laboratory or class-room. It fulfills this purpose well.

Its scope is indicated by the following chapter headings: General

Chemical Tables, Properties of Matter, Heat, Hygrometric and Barometric Tables, Sound, Electricity and Magnetism, Light, Miscellaneous Tables, Definitions and Formulæ, Laboratory Arts and Receipts, Measures and Units, Wire Tables, Mathematical Tables, Apparatus Lists, Bibliography, Problems.

The data is chosen from authoritative sources and is readily accessable. The recipes constitute a small well-selected list.

The compilers have evidently made every effort to eliminate all chaff and to insure the high quality of the wheat. Libraries, teachers of chemistry and of physics, and practical chemists and physicists have been consulted freely and to such purpose that a handbook of merit has resulted.

Any one desiring a ready reference book for data in chemistry and physics will probably find this the book they are seeking.

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An Army Woman in the Philippines and the Far East. By Caroline S. Shunk. Kansas City, Mo.: Franklin Hudson Pub. Co. 5¾"x7½". 183 pp. il. 1914. Cloth. Price, $1.25.

This book is made up of extracts from letters of an Army officer's wife describing her experiences in the Orient.

The narrative begins with the sailing of an army transport from San Francisco and covers the localities and the life known so well by many army people.

That is, the gifted authoress describes Honolulu, Guam, Manila, Camp Stotsenberg, Nagasaki, Miyajima, Kioto, Miyanoshita, Yokohama, Tokio, Shanghai, Canton, Hong-Kong, and finally the sailing for home.

She describes her life in all these places however in way so attractive that one wonders how she did it and yet those of the Army who have been in the Orient see at once that her narrative is exact in every detail.

Civilians contemplating a trip to the East can not find a better or more interesting picture of what to expect than is given in this story while the men and women of the Army are indebted to Mrs. Shunk not only for placing before them the life they also led while on foreign service but for doing it in such a cheerful and witty manner that her book can be read and reread with the greatest pleasure.

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JOURNAL UNITED STATES ARTILLERY

PRIZE ESSAY COMPETITION

1916

The JOURNAL U. S. ARTILLERY announces the following for its annual competition.

PRIZES

One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the JOURNAL.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the JOURNAL OF THE UNITED STATES ARTILLERY. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the JOURNAL and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

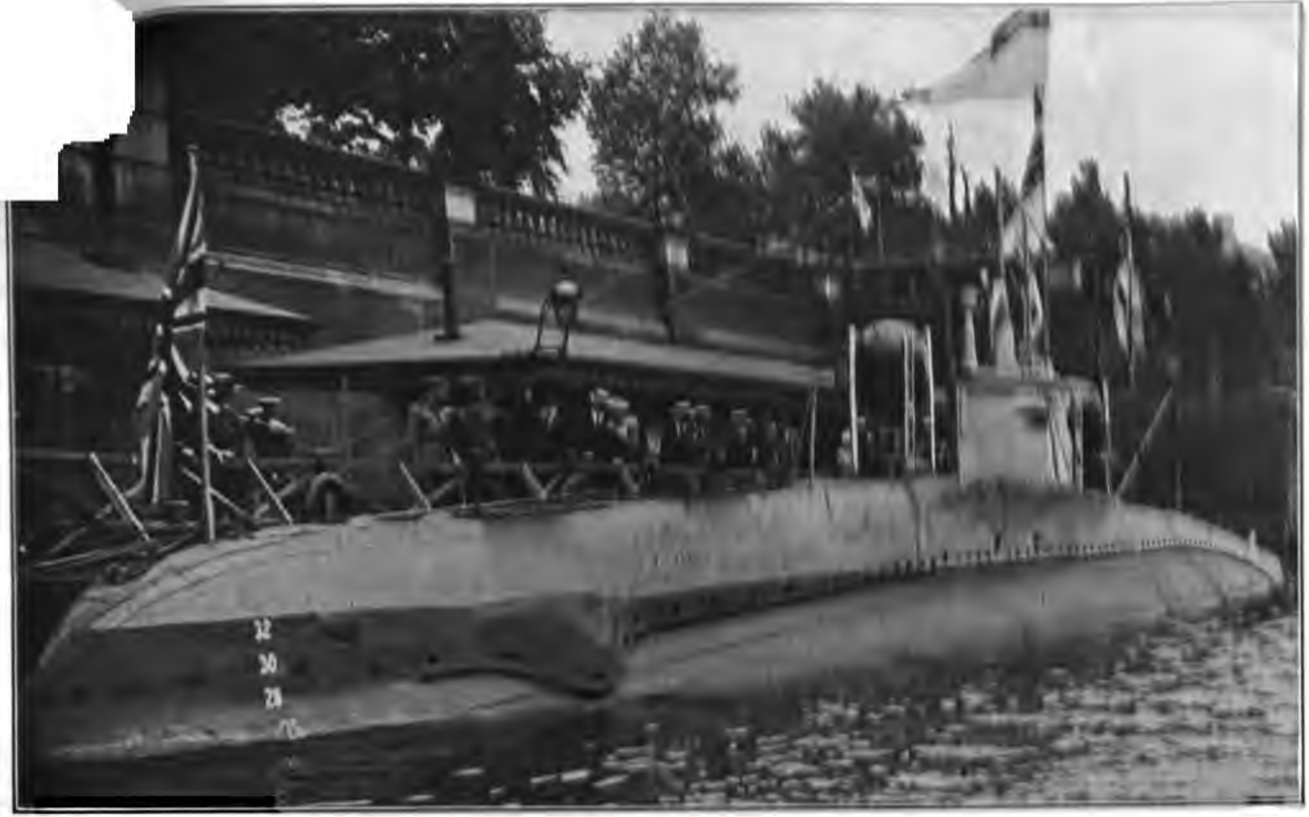
(f) Copy must be received on, or before, December 31, 1916. It must be addressed JOURNAL U. S. ARTILLERY and the envelope must bear the notation, "Essay Competition."

NOTICE

The JOURNAL U. S. ARTILLERY desires to receive from its readers, titles of subjects which they consider would be of interest to the service. A title will be published (either on the "Prize Essay" announcement page, or immediately following "Short Notes") until a paper on that subject has been received.

The following has been suggested:

"National Guard Coast Artillery: Armory Instruction, and Preparation for Service Target Practice and Service Conditions."



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THE GERMAN SUBMARINE MINE-LAYER "U C 5" AT TEMPLE PIER IN LONDON

(FOR DESCRIPTION, SEE PAGE 227)

JOURNAL
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QUARTERING AND PROVISIONING COAST DEFENSE GARRISONS IN TIME OF WAR

BY CAPTAIN JOHN S. JOHNSTON, COAST ARTILLERY CORPS

The question of quartering and provisioning garrisons of harbor defenses in time of war is not merely a matter of providing shelter and supplies; it involves the much more vital problem of providing for the security and safety of the garrison and its supplies.

The importance of this latter problem cannot possibly be overestimated. It may be said to be the foundation upon which the whole system of defense rests. For unless the garrison be able to live within the defenses while the latter are under fire, it is obvious that any system of defense must fail before a sustained attack. It is apparent then that it is not possible to devote too much care and study to the question of living arrangements for the garrison in time of war.

In order to ascertain the requirements of the garrison with respect to living arrangements, we must consider the conditions under which the garrison will probably be required to live in time of war, and the bearing of these conditions upon the question under discussion.

These conditions will be governed, to a large extent, by the organization of the landward defense of the harbor defenses; that is, upon whether the defenses are to be organized as *fortresses* or as *forts*. In the former case the landward defenses would be located at such a distance from the harbor defenses as to prevent the latter from being reached by hostile fire from the landward side; no special protection against such fire would be necessary. The problem of supply would devolve upon the fortress staff and no special measures in that connection would be required of the harbor defenses. In the latter case, the land defense lines need only include the area covered by a single group of harbor defense, including armament and accessories. In this case all essential elements of these defenses must be protected against fire from the landward as well as the seaward side and each separate group must be prepared to maintain itself indefinitely upon supplies stored within its own lines.

The question as to which of these two general plans of defense should be adopted, is not within the province of this discussion. In any event, regardless of the respective merits of the two systems, and considering the limitations inherent in our military policy, defensive plans should be based on what we *can* do, not on what we *ought to do;* on what we *know we will have,* not on what we *believe we ought to have.* If, when our coast-line is attacked, the harbor defenses fail to perform their mission, the result will be exactly the same whether they fail because we have failed to do what we could have done, or because some one else has failed to do what he should have done. Unless definite steps have already been taken to organize our harbor defenses as fortresses, we do not *know* that they will be so organized. Although the most perfect plans to that end may have been worked out, so long as these plans involve elements which do not now exist we can not *know* that it will ever be possible to put them into effect. But, if our harbor defenses were organized as small compact forts, with their land fronts reduced to an absolute minimum and adequately fortified, and every essential element within them adequately covered against hostile fire, we do know that such works could either be defended by the artillery garrisons without assistance, or that such assistance as might be necessary could be counted on with certainty.

Hence, whatever tentative defense plans may have been adopted, steps should be taken at once, now, in time of peace when time is available, to organize our harbor defenses upon lines similar to those suggested above, such that their defense will be possible with means that we know will be available when needed. All the features of this organization which relate to quartering and supply of the garrison can be, and should be, completed before hostilities begin.

In considering plans for quartering and supplying the garrison the first and most important point to be considered is the tenability of the defenses.

Without men to man them the most perfect harbor defenses are, of course, worthless. On the other hand, the mere fact that the defenses are manned will frequently deter the enemy from attempting to enter the defended waters, although the defenses, themselves, may actually be powerless to prevent him from doing so.

Johnson, in his *Siege and Defense of Charleston Harbor,* tells us that the Confederates maintained a garrison in Fort Sumter for months after its armament had been rendered useless, believing that the Federal Navy, after its experiences in attempting to pass the work during the naval attacks on the harbor, would not repeat the attempt so long as the work was manned. That their confidence was justified seems to be demonstrated by the fact that during the period in question the Navy made no attempt to pass the work but did make several costly attempts to capture it.

While history affords numerous instances in which naval forces have attempted to force an entrance into defended waters, it affords few, if any, instances of such attempts being repeated, so long as the works were known to be manned, after the defenses had once conclusively demonstrated their ability to defeat them.

Instances are numerous in which inferior works tenaciously held have defeated attempts of powerful fleets to pass them; and instances are almost as numerous in which much more powerful works have failed to accomplish their mission because their garrisons were driven out by hostile fire.

It appears, then, that in the problem of harbor defense the maintenance of the garrison is a factor of equal, if not greater, weight than the maintenance of the armament.

In order that the garrison may continue to occupy the works indefinitely under all conceivable conditions of hostile attack, two things are absolutely indispensible: Shelter from hostile fire; and unfailing supplies of food and water.

These requisites for the garrison are no less essential to the success of the defense than cover and ammunition for the armament; and to leave them to chance or hasty and ineffective improvizations is as unjustifiable as would be such a course with respect to the armament. The problem of providing them in time of war should be studied with the most extreme care, and measures should be put into effect in time of peace to meet every condition affecting the problem which can be foreseen.

The solution of the problem will depend to so great an extent on local conditions that a general discussion must confine itself principally to a statement of the ends to be attained, leaving the methods to be adopted in attaining them to be determined largely by the conditions at each place.

The ends to be attained will be considered in the order in which they have previously been stated.

Shelter from Hostile Fire

When it is considered that the artillery garrisons of coast defenses are tied to fixed positions; that these positions can not be changed, no matter from what direction they may be attacked; that the movements of the garrison must be confined to a comparatively restricted area in the vicinity of these positions; and that the garrison must remain within this area no matter how severe a fire may be directed upon it, from what direction such fire may come or how long it may be continued, the necessity for providing quarters for the garrison, sheltered from hostile fire, would seem to be so obvious as to require no discussion. The only questions open to argument are as to what constitutes adequate shelter, how it is to be obtained, and to what extent the plans decided upon should be carried out in time of peace.

In considering the first question it must be borne in mind that, regardless of the character of any hostile attack, its severity, the direction from which it comes or its duration, the following conditions must be met:

1. The garrison must always be able to man the armament.
2. It must continue to live—to eat, drink, rest, sleep, and perform all the other functions of life.

The first of these conditions requires that troops be quartered within a reasonable distance of the armament to which they are assigned; that communication between their quarters and their stations must be secured against interruption from any cause; and that they must be able to pass back and forth between their quarters and their stations without being exposed to hostile fire.

The second requires that quarters, wherever located, must be securely protected against hostile fire from any reasonably conceivable direction, must be reasonably comfortable, must be provided with all necessary appliances for cooking and sanitation and must have secure access to supplies of food and water.

While, as stated above, the means by which these ends are to be attained are governed almost entirely by local conditions, the following principles of general application should be observed in the solution of the problem.

A satisfactory plan for quartering the details manning the armament should first be decided upon. The troops available at any of our coast defenses at the outbreak of war will probably never be able to furnish more than one relief (manning party) for the armament, and a considerable period of time must elapse before additional troops can be provided. During this period the garrison must be in constant readiness to man the armament at a moment's warning—their situation will be similar to that of troops manning the front line of trenches in a fortified position; but, while troops manning such trenches are usually relieved at frequent intervals, the artillery garrison must remain on duty indefinitely. During this period they must not only remain in the immediate vicinity of their stations, but they must *live* there. Their quarters, therefore, should afford as great a degree of comfort as the situation will permit.

Quarters fulfilling the requirements previously stated should be provided in the immediate vicinity of each element of the defenses (battery, searchlight, observing stations, etc.); every man in the garrison should be able to cover the distance betweeen his quarters and his post in not more than two or three minutes. At most of our more recent fortifications such quarters have been provided, or rooms suitable for that purpose are available. Where such quarters are available, all that remains to be done in time of peace is to see that everything necessary to their occupancy is provided and, so far as practicable, installed. Especial attention should be given to providing adequate cooking facilities. Camp methods should be resorted to only where no better facilities are obtainable. The fact that troops are engaged in actual hostilities is, of itself, no reason why they should be subjected to *unnecessary* discomfort or inconvenience. The place selected for kitchens should be rendered absolutely impervious to hostile fire. Men can endure almost any form of hardship, or any degree of exertion, as long as they are well supplied with food—and nothing will destroy their effectiveness so quickly as the lack of food. Where kitchens are located in, or adjacent to, batteries, electric cooking apparatus should be employed. Its use would simplify the problem of ventilation and reduce the danger from fire. It would also permit the use of interior, and hence safer, rooms for kitchens. For the same reasons it should be used for heating quarters.

If no rooms or quarters are already provided, provision should be made for them at once. If the ground affords sheltered sites sufficiently near the posts of the various detachments, quarters should be designed to be erected on these sites. If no such cover is available, artificial cover should be provided. All the work necessary to prepare these sites should be done in time of peace. They should be cleared and graded when necessary; covered ways leading to all the elements of the defenses to be manned by the occupants, and covered roads leading to supply magazines should be constructed; water and sewer pipes should be laid; concealment should be provided for and, in short, every thing that can be done in time of peace should be done.

Plans should provide for quartering troops in temporary barracks instead of camps. The former occupy less space than the latter and consequently simplify the problem of cover; they are more comfortable, more convenient, more sanitary and, in the long run, less expensive. As a rule, quarters should be erected in time of peace. If, however, climatic conditions are such as to subject them to rapid deterioration, they should not be erected; but materials for them should be obtained and kept on hand, cut to size and arranged so that they can be put together in the shortest possible time.

All plans for quartering the garrison should include plans for caring for sick and wounded. While perhaps not within the province of this discussion, the following suggestion is offered:

A dressing station, under secure cover, should be provided for, centrally located with respect to the defensive works and connected by covered ways with each separate element of the defenses. Where the works comprise several widely separated groups, a separate dressing station should be provided for each group. These stations should be on the covered road to be mentioned later. Hospitals should, wherever possible, be located at a considerable distance from the works. Positions for dressing stations should be located, and these positions and the necessary communications should be prepared in time of peace.

The question of providing accommodations for additional reliefs for the armament need not be taken up until something definite has been done toward providing such reliefs. If the relief manning the armament is so quartered that its numbers can live in comfort when not actually engaged in the service of the armament, it is probable that no additional reliefs will be necessary. If, however, it becomes probable that such reliefs will be provided in time of war, arrangements for their accommodation should be completed in time of peace.

Plans for quartering these reliefs should conform to the requirements previously stated, except that, whenever possible, quarters should be located at some distance from the batteries. They should be connected by covered roadways with each separate group of works and with the supply magazine.

If it is certain that troops to provide these reliefs will be available at the outbreak of war, the special arrangements previously outlined for accommodating the relief on duty will be unnecessary.

Quarters for troops assigned to land defense should be provided for. If suitable sites for such quarters are available on land owned by the Government, these sites should be prepared in time of peace in the same manner as those for the artillery quarters.

If conditions require the selection of sites not on government land, such sites should be selected in time of peace, detailed plans for preparing them for occupancy should be prepared, and all matériel necessary to the execution of these plans should be obtained and kept on hand.

FOOD SUPPLY

Food for the garrison is as necessary for the maintenance of the defense as ammunition for the armament; hence the security of the food supply should receive as careful consideration as that of the ammunition. Storerooms should be provided, protected as carefully from hostile fire as are the magazines. Unless its communications with an outside source of supplies are absolutely secure, each group of defenses organized as a fort should be provided with such a storeroom, or, as it may be more properly designated, supply magazine.

This magazine should be connected by tunnels or covered ways with the quarters of each detachment, and by a covered roadway with the point at which supplies for the fort are delivered. This point should be selected with great care. If possible, it should be so located that it can be approached under cover from fire from either land or sea.

If power for that purpose is available, the supply magazine should be fitted with a cold storage compartment.

All this work should, of course, be done in time of peace. The outbreak of war should find rations for the garrison, including land defense troops, for at least thirty days, stored in each magazine.

WATER SUPPLY

The security of the water supply is of even nore importance than that of the food supply. The supply must be wholesome and absolutely secure against interruption or molestation. The first requisite to the latter condition is that the source of supply be located inside the land defense lines. This is absolutely indispensible. If no natural source of supply fulfilling this condition is available, a plant for distilling sea water should be installed.

Pumping plants, distilling plants, mains and supply pipes should be adequately protected against fire of any description and from any direction. To provide against break downs in pumping or distilling plants a reservoir, to hold not less than a ten day's supply for the garrison, should be provided.

Some system which will ensure an adequate and certain supply of water must be provided in time of peace. Such a system can not be hastily improvised—except in rare cases, it could not be improvised at all—and a failure of the water supply would mean the abandonment of the defenses.

OTHER SUPPLIES

These as a rule require no special provision in time of peace.

An ample stock of medical and surgical supplies should be on hand at the outbreak of war. These should be stored, in time of war, in the supply magazine and storage space should be provided for them in planning that building.

No special provisions for supply of clothing are necessary. Men would ordinarily have in their possession at the outbreak of war sufficient clothing to last them through any period ng which the defenses are liable to be cut off from supplies.

Motor vehicles should be used in time of war for such transportation within the forts as may be necessary—animals would be in the way. These vehicles should be obtained in time of peace so as to be on hand when needed.

CONCLUSION

A plan for quartering and supplying the garrison of each separate group of harbor defenses in time of war should be prepared at once, and carried out at the earliest possible date. Plans should be prepared in detail and reduced to writing with maps, drawings, etc., so that the work may be carried to completion regardless of changes in personnel.

The plan adopted should be based upon a careful study of the following points:

Character of attacks to which defenses might be subjected.

Forces which may, with certainty, be counted upon to be available for duty, in the particular coast defenses under consideration, at the outbreak of war.

Best disposition to make of these forces.

Best organization for defense, i.e., grouping of defenses, defensive lines, works, etc.

Will this disposition permit enemy land forces to approach within field gun range of the harbor defenses? If so, from what directions will his artillery be able to fire upon these defenses?

From what directions can hostile vessels fire upon the harbor defenses?

What rooms or buildings in the vicinity of each of the elements of the defenses are now provided, or can be provided, with cover against fire from all of the foregoing directions?

What part of the garrison should be quartered in such rooms or buildings?

Does the ground in the vicinity of the defenses afford any sites covered against fire from all the above mentioned directions? If so, considering the dimensions of these sites and their location with respect to the various elements of the defenses, what part of the garrison should be quartered in each?

Is it probable that more than one relief for the armament will be available at the outbreak of war?

If conditions require that garrison be quartered under cover, and the ground affords no covered sites, what is the best plan for providing such cover? a. Against fire from sea only; b. Against fire from both land and sea.

Considering organization for defense, what plan will best ensure adequacy and security of food supply?

Considering character and location of quarters, communcations, etc., and question of cover, what is best location for supply magazine, or magazines?

Is source of present water supply within lines selected for defense? If not, is any natural and suitable source obtainable within these lines?

In the preparation of these plans, as well as in all other matters relating to the defense of our coast defenses, there is only one safe rule to follow; and that is to remember that the initiative must always lie with the enemy; that his operations against the defenses may follow any conceivable plan not absolutely precluded by the terrain; that, as a rule, we can not count, with certainty, on being able to prevent him from *undertaking any operation he may choose* and that we must, therefore, be prepared in advance to meet any conceivable form of attack which is humanly possible.

FIRE CONTROL SYSTEM AND FIELD PLOTTING BOARD FOR INDIRECT LAYING OF SEACOAST GUNS AND THOSE OF THE MOBILE ARTILLERY

By Captain WILLIAM T. CARPENTER, Coast Artillery Corps

The time has arrived for us to give serious attention to the fire control of the guns of our seacoast defenses against landward targets. Most of these guns have azimuth circles for indirect laying, and it is understood that steps have been taken to provide azimuth circles for the remainder of them.

The following is suggested as an accurate and economical method of fire control for indirect laying. It is especially suited to the troops of our Coast Artillery in the operation of our present seacoast ordnance or of any mobile artillery that may be assigned to our coast defense areas.

In connection with this article, attention is invited to the articles in the July-August, 1915, and January-February, 1916, numbers of the Journal of the United States Artillery, on "The Use of Our Seacoast Guns and Mortars in Land Defense" and "The Use of Heavy Mobile Artillery in Conjunction with Our Seacoast Armament," respectively, by First Lieutenant Meade Wildrick, C. A. C.

In general, the methods of controlling the fire of guns by indirect laying must depend upon accurate information of the geographical position of the target with reference to that of the gun. The position of the target may be located by any of the systems involving the use of aeroplanes, by field artillery methods depending upon the observation and correction of fire from observation stations, or by exact information of the azimuth and range obtained by means of instruments of precision, such as coincidence range finders or azimuth instruments, in connection with a system of observation stations or base lines. It may also be located by special observers or scouts situated near enough to the front to note the position of the target with reference to some special feature of the terrain that is noted on the map. The position of the target

Map System of Squares

A map system of squares should be adopted covering all the areas within the present and probable ranges of the guns and mortars of our seacoast defenses. This area to be considered as the inner zone of the system. The system of squares adopted should be such as will permit of increases by rectangular zones to meet the location of movable armament farther to the front. The inner zone to be laid out with a simple series of numbers that would permit of brief designations of the squares. The squares should be one thousand yards on the side, which will permit of the location of targets by coordinates from the southwest corners of the squares, in tenths and hundredths. The sides of the squares should run north and south and east and west.

Fort, fire, and battery commanders of the permanent defenses should provide themselves with plotting boards bearing maps of the squares within the fields of fire of the batteries and guns of their commands. These plotting board maps should show the exact sites of stations within their areas.

Equipment of Observation Stations

The stations selected should be listed and described in order of importance as "Main Stations" and "Auxiliary Stations." A liberal amount of equipment should be supplied and kept in store in the coast defenses for use at the main stations.

The occupation of the stations would depend upon the landing operations of the enemy and the progress of same. In the event of destruction of a station, the nearest suitable site would be selected as a substitute.

Each station should be manned by an observer and a telephone operator. Each station in the inner zone should be connected by telephone with the station of the fort commander whose guns cover the area, and those stations covering the same area should have a party telephone line between stations. Ordinarily, the local telephone service would supply sufficient power for four or five telephones in parallel. The system should contemplate the full use of the local commercial telephone service. Each station of the outer zones should connect with the field station of the fire commander of the movable armament covering the zone.

All stations should contain:

One coincidence range finder or azimuth instrument. (Depending upon extent of field of view and whether or not horizontal base system would be desirable. Coincidence range finders to have azimuth circles.)

One field plotting board. (As described below.)

Two pair of powerful field glasses, type EE. (One for each of manning party.)

One artillery combination flag kit.

Two telephones.

METHODS OF POSITION FINDING

With the above equipment for observation stations, positions of targets may be determined as follows:

a. Coincidence range finders: Azimuths and ranges from the observation stations to be telephoned to fort commanders. The position of target to be plotted at fort or fire commanders' stations or at batteries. If plotted at fort or fire commanders' stations, the azimuth and range, or the exact position by co-ordinates in a square of the map system of squares, to be telephoned to the battery. This method of plotting will require azimuth circles on plotting boards around each observation station or a protractor sheet for centering over stations.

The plotting could be done at observation stations as outlined in (c).

b. Azimuth instruments: The azimuths of the target from two stations to be telephoned to fort commanders. Plotting by either of above methods or as outlined in (c).

c. Field plotting boards: By means of the field plotting boards described below, the exact position of the target in a square may be plotted at an observation station from readings obtained as in (a) and (b) above, or from azimuth readings obtained from field plotting boards at two stations. The co-ordinates of the position of the target to be telephoned to fort commander. This data is then applicable to all fire commands and batteries covering the position. This latter method seems to be the simplest. It would expedite the assignment of fire commands and batteries to different targets. It would also reduce the chances of error in the transmission of data and in plotting.

FIELD PLOTTING BOARD

The plotting board, to consist of a white pine board 3′ × 3′ × 1″, on which is to be mounted a light blue print map of the local area, is shown in Figure 2. Two (2) clear transparent celluloid or xylonite protractor sheets and two (2) small brass sighting arms to be furnished with the board. The sighting arms to have front and rear sights and a vernier on rear end for reading angles to 1/100th of a degree. The arms to have a center edge for drawing the line of sight on the map and a scale for measuring distances or ranges for nearby guns as shown in Fig. 1. The map being that portion of the map of squares including the local area to the front. The site of the home station and adjacent stations being carefully marked thereon with sufficient data for orienting the map and any observing instruments used at the station. One of the protractor sheets to be centered over the home station and fastened to the board by thumb tacks. One sighting arm to be pivoted over the home station. The other protractor sheet and sighting arm to be used in laying off the reading obtained from any other station shown on the board, by centering the protractor sheet and arm over the same. Targets to be located and plotted on one board by means of the local reading and the plotted line of sight from the other station. Ordinarily a tripod would not be required at the observation station. The board should rest on the ground or on an inprovised stand.

By means of this plotting board, a combination of horizontal base and plane table methods is obtained that will accurately locate the position of a target in a square within a few yards. The board may be used for plotting readings from azimuth instruments at long ranges or it may be used alone at a station to locate targets at close ranges, by means of data from one other station, without the aid of an expensive azimuth instrument. The range of the board will depend upon the state of the atmosphere, but ordinarily field batteries and small bodies of troops can easily be seen for distances of two to four miles with the naked eye. After first picking up a target by means of field glasses, the observer can take readings with the sighting arm to much greater distances. In a clear western atmosphere, and over water or snow, such targets may be located at much greater distances.

The party telephone line appears to be very desirable to enable observers to confer in regard to targets and to take simultaneous readings on one selected. Otherwise, connections would be necessary through the fort commander's switchboard and it is thought that a telephone switchboard of fifty or one hundred drops should be furnished in time of war for this service and other important outside communications.

This method of plotting is also suitable for use with mobile artillery where an accurate map of the locality is at hand. The plotting board may be set up and operated at any place, provided the map is accurate enough for orientation. It can be operated by anyone who understands the plane table and horizontal base principles involved.

In the coast defense a complete set of tracings should be made from the complete map of squares. These tracings should be 2′ 10″ × 2′ × 10″, in size to fit the plotting board. From these tracings a sufficient number of light blue prints can be made for observation stations, mobile batteries, etc., at slight expense. In cases where targets are visible only from two stations that do not appear on the same plotting board map, the azimuth readings must be telephoned to fort commander's station for plotting thereat.

The protractor sheets with a small ruler arm with vernier can be used on the fort or fire commanders' plotting boards for locating targets from any two stations as required. The protractors should be centered over the sites of stations as marked on the plotting boards and oriented by means of the north and south lines marking the limits of squares. This method will be much better than to have azimuth circles drawn on these maps around the position of each station.

These protractor sheets can be purchased in lots of one hundred, at $2.60 each; and in lots of one thousand, at $.95 each. The arms will cost about $2.50 each when made of brass. The cost of one plotting board, complete, will be approximately as follows:

1 Plotting board, 3′×3′×1″	$ 2.00
2 Protractor sheets, 11″×11″	5.20
2 Sighting arms, brass	5.00
Total	$12.20

(A tripod, where required, would cost $12.00 in addition to above.)

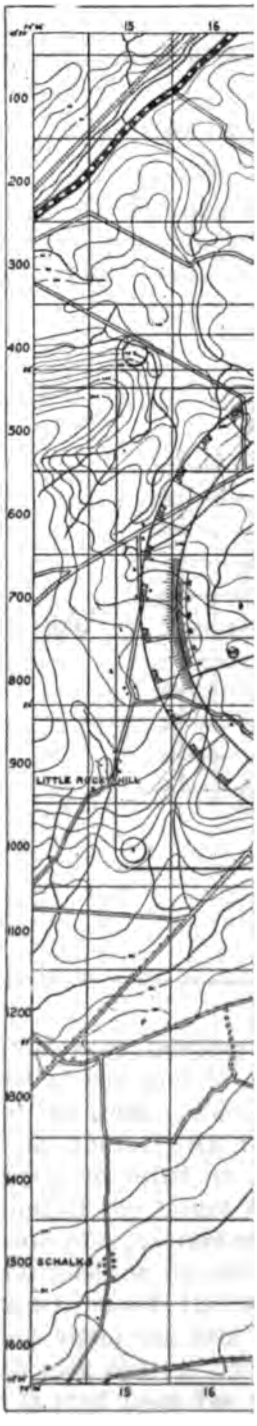
OPERATION OF THE PLOTTING BOARD

The details of the protractor sheet and sighting arm are shown in Figure 1, and the method of locating targets by squares is shown in Figure 2. In the latter figure, the map represents a section of the country in the vicinity of the Coast Defenses of Durazzo. It shows observation stations Nos. 1, 3, and 4 on suitable hills, and No. 2 on a school house. Each of these stations is connected by telephone with the fort commander's station at Durazzo. As this group of stations covers the same general area, they are connected by a party telephone line. The observer at station No. 2, having sighted a field battery going into position to the northeast of Blackhorse, calls up station No. 4 and reports the position of the battery and requests the azimuth if it can be obtained.

He points his sighting arm at the center of the target and draws a line on his map along the center edge of the arm. After obtaining the azimuth, 251.15 degrees from station No. 4, he locates the loose protractor sheet and sighting arm over the site of station No. 4 and, after setting off the angle by means of the vernier, draws a line along the center edge of the arm until it intersects the extended line of sight drawn from his own station. The lines intersect in Square No. 523. He then determines the co-ordinates of the point of intersection by means of a small scale graduated in tenths and hundredths on the sides of the square, or by means of a small square co-ordinate or scale sheet (Fig. 3) of celluloid or tracing cloth as shown lying over Square 523. He determines the position within the square as 86-23, and then reports the target by telephone to the fort commander as Field Battery—Square 523—position 86-23, with such other information as he may think advisable. The position numbers being the co-ordinates of the position in hundredths from the southwest corner of the square. The horizontal co-ordinate being given first and the vertical co-ordinate last.

The fort commander on receiving the report from station No. 2, can at once give the description and location data to his fire or battery commanders without the delay of plotting. Finally, at the battery assigned to the target, the point is located in Square 523 on the landward plotting board, and the gun arm brought up and the range and azimuth read off to the guns after the usual corrections, with additional range correction to compensate for difference in level between target and battery.

For the purpose of observation and correction of fire, the fort commander should have the observer at station No. 2 informed of the time of the first shot at this target and instructed to plot the burst. He, in turn, would notify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or, if it is not long enough, by means of a longer scale, the straight edge of which could be used as an extension of the sighting arm in the first place when laying it in the direction of the target. The aiming points for the other guns in the battery or group would be at points to right or left of the aiming point for the directing gun, the distances being equal to their respective displacements from the directing gun. Observation and correction of fire as indicated above.

The scale on the sighting arm shown in the figures is graduated to 5000 yards. The forward end could be extended several inches for use with mobile artillery where the measurement of ranges would be desired.

NOTE.—In view of the fact that the azimuth instrument Model 1910, costs $347.60, and coincidence range finders much more, it is thought that the field plotting board is worthy of consideration in connection with a fire control system for landward defense.

PROJECT FOR COAST DEFENSES*

BY CAPTAIN STANLEY D. EMBICK, COAST ARTILLERY CORPS

GENERAL CONSIDERATIONS

FUNCTIONS OF THE SEVERAL ELEMENTS OF THE NATIONAL DEFENSE

In approaching the problem of our national defense one is impressed both with the magnitude of the interests to be defended, and with the wide extent of the frontiers on which we are exposed to attack. The seaboard of the continental United States on the Atlantic and Gulf coasts exceeds three thousand miles; on the Pacific, not including Alaska, it is half as much more. The acquisition of the Panama Canal, strategically an integral part of our coast-line, and of Hawaii, which bears so important a relation to out Pacific coast, has extended the seaboard by many thousand miles.

In considering the question of the defense of these wide areas it should be borne in mind that in a military sense the United States occupies an insular position. The absence of a strong military power on the North American continent precludes an attack in force, except from over seas. For the United States, therefore, the problems of home defense resemble more nearly those of England and Japan, than those of the states of continental Europe, and, as in the cases of the former, the fleet becomes of necessity the first line of defense, and an invasion in force can not be expected to occur until an enemy has obtained command of the seas. The initial act of Japan in her war with Russia was to cripple the Port Arthur fleet, and thus to secure for herself command of the sea, a condition which she recognized as a prerequisite to the transporting of her invading forces to Manchuria and their subsequent maintenance in that country. Similarly the fundamental purpose of English strategy in the present war is to assure herself such command of the sea as will preclude an invasion of her coasts, while leaving her free to transport her troops in safety to continental Europe.

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* This article was written in 1915.—Editor.

In consequence of the insular position of the United States, it may be said to be broadly true that our navy constitutes the first line of defense. The mission of the Navy will be to secure and to maintain control of the sea. To accomplish this, however, it must be free to assume the offensive, to seek out and oppose the fleets of the enemy upon the high seas; and it will be free so to operate only when our coasts are protected by fortifications and by land forces against the raids of an enemy. Otherwise our fleet will be relegated to the rôle of passive defense and tied down to the protection of a limited portion of our coast-line, leaving the enemy free to operate at will against all other portions.

Our naval forces to be employed effectively must be concentrated. If dispersed and assigned to specific localities for local defense, they will be beaten in detail. The Japanese naval victories in the Russo-Japanese war were the inevitable consequence of the division of the superior Russian naval forces between Port Arthur and the Baltic Sea.

The suggestion is heard occasionally that adequate protection of the United States can be assured through an increase of the Navy, and to the exclusion of the employment of land forces. The adoption of such a policy would require the maintenance in every possible theater of operations of a fleet greater than the combined naval force of the enemy, a procedure that with our vast extent of coast-line would involve a prohibitive expense. It would entail the assignment of naval vessels to local harbor defenses, work for which they are far less adapted than our coast fortifications, as the former are much more costly, both as to first cost and as to cost of maintenance, are shorter lived, more vulnerable, and less effective than the latter. England, notwithstanding her limited coast-line and her preponderant navy, kept constantly at the two-power standard, deemed it wise to maintain strong coast fortifications and an army, prior to the present war, of approximately 600,000 men, including territorials.

The purposes to be accomplished by seacoast fortifications may be summarized by saying that they will protect our important seacoast cities and naval bases against naval attack; they will prevent the occupation by an enemy of important strategic harbors; they will free the fleet for its proper rôle of offensive action, and they will afford secure bases in which our Navy may refit. Naval attacks upon our coasts may be contemporaneous with or even may precede the declaration of war. In the absence of coast defenses a naval raid upon one of our important seacoast cities would result in great damage, probably in the levying of an indemnity, and possibly in the more serious consequences of a dispersion of our fleet for harbor defense that would preclude offensive action, permit it to be beaten in detail, and leave the country open to invasion. This contingency is to be feared particularly with a republican form of government, as was evidenced during the Spanish-American War, when notwithstanding the weakness of the Spanish fleet, the fact that the condition of our coast defenses did not inspire the public with confidence led to a popular clamor that hampered seriously the conduct of naval operations. In a marked sense, therefore, coast fortifications may be said to supplement the Navy and to increase both our defensive and offensive powers. Another and important objective obtained by effective seacoast fortifications in a country like the United States that occupies an insular position and has large latent military resources, is that as such fortifications will preclude damage from hostile naval raids, they will permit our battle fleet to defer, if need be, at least to some extent, a decisive naval engagement to afford time for the partial development of such resources.

It was due to the securely defended condition of the Japanese ports that the Japanese fleet was free to operate against its proper objective—the Russian Port Arthur fleet—without being recalled to guard its home ports against raids by the Vladivostok squadron. The present war is replete with examples of the broad strategical rôle of coast fortifications. The strong fortifications of the English coast cities have permitted the English to hold their naval forces concentrated at a strategical point remote from their centers of population, and have restricted the operations of the raiding German cruisers to attacks upon comparatively unimportant and unfortified towns. The complete security of the German fleet and of the German coast against attack by the superior English naval forces, has been rendered possible by the strong German coast fortifications. The coast fortifications at the Dardanelles prevented the capture of Constantinople by naval attack, revealed the objective of the Allies, and afforded the Turkish forces an opportunity to prepare for the costly and so far abortive land operations to which the Allies were forced to resort upon the failure of their naval attacks. The fortifications at the entrance to the Gulf of Riga have prevented the capture of Riga, and the turning of the flank of the Russian forces.

The provision of fixed seacoast fortifications has been limited to those harbors that are deemed to be of such strategic or commercial importance that their exposure to bombardment or to occupation by the naval forces of an enemy would be inadmissible from the standpoint of national interests. Obviously the provision of fixed fortifications covering our entire coast-line would be wholly impracticable. The defense of the stretches of coast-line intervening between the fortified harbors is primarily a function of the Mobile Army. In a broad sense it may be said that the primary function of the Coast Artillery is to oppose direct naval attack; that of the Mobile Army is to oppose an invading army. The Mobile Army is our second and final line of defense. The decisive defeat of the naval forces of the United States may be expected to be followed immediately by the embarkation of an enemy force for the invasion of continental United States. If the United States possesses a strong Mobile Army, the invading force can be met and defeated at the beach, or at least prevented from penetrating into the interior, as is illustrated by the recent operations at the Dardanelles. The operations of the enemy will then be restricted to the capture of our over-sea possessions and to the destruction of our commerce; our central citadel will still be secure.

Without a strong mobile army the operations of the invader can not be defeated. His progress will be rapid, and in a very short time, far less than that required for the development of any material part of our latent military resources, he may be expected to be found in possession of large areas of the most populous and economically important sections of the country. It will then remain for him to impose his terms at will upon the conquered areas. However intolerable these terms may appear, there will be no recourse.

One of the developments of the European war that promises much in its application to our defensive problem, is the introduction of large caliber movable armament. The cess of the recent landings at the Gallipoli Peninsula were dered possible only by the covering fire of the fleet. His- y is replete with similar examples of the necessity for naval operation for the accomplishment of landings on hostile shores. Fortunately those sections of our coast-line that are of the greatest strategic importance are paralleled by coastal railways, so that by the employment of large caliber movable coast artillery mounted on railroad trucks it is expected that in the event of an attempted landing in those sections, the warships and transports of an enemy will be held at such a distance from the shore as will prevent the hostile naval batteries from sweeping the beach and covering the landing, and thus offer to our mobile army an opportunity that otherwise would probably not be afforded of defeating the invaders before they can set foot on the shore.

NAVAL OPERATIONS AGAINST OUR COASTS

Naval operations against our coasts may take one or more of the following forms depending upon the value of the objective to the enemy and the hydrography of the particular locality considered.

a. Blockade.
b. Bombardment.
c. Deliberate attack.
d. Raids.

Blockade

A blockade may be undertaken for the purpose of shutting up in a harbor an inferior fleet (a war blockade) or of interrupting and destroying the commerce of a great port (a commercial blockade). Either form of blockade presupposes the superiority of the enemy at sea. A war blockade might be instituted by an enemy to insure the safe transport of his troops, the unmolested carrying on of his commerce, or the safety of his own coast and bases. Such a blockade may take the form of a close investment by the blockading forces, as in the blockade of Port Arthur by the Japanese fleet or in the present investment of the Dardanelles, or it may take the form of the blockade established by England against Germany in the present European war. It is, however, only in the case of a blockade of the former character, that is, a close investment, that coast fortifications would be called on to play other than an indirect part. In such an investment the blockading squadrons may be expected to remain well out of the range of the fixed defenses, but to make constant effort to close in and to bombard the fixed defenses and the cities and naval utilities which they defend. The development of the submarine will render extremely difficult the maintenance of such blockades in future.

Bombardment

Bombardments may be undertaken for the purpose of inflicting material damage upon our important seacoast cities; of destroying naval docks or other important naval utilities; of rendering untenable to our warships a harbor in which they have taken refuge; or of silencing important seacoast batteries.

The results of the Dardanelles operations have confirmed the view generally held heretofore that coast fortifications may be expected to suffer comparatively little from a naval bombardment, even if of a prolonged and permanent character. The situation, however, is quite different in the case of the compact and wide targets presented by closely built cities, such as New York, Boston, or San Francisco, where practically every shot may be expected to take effect. It is interesting to note in this connection that the stipulations of the Hague Convention as to the freedom from bombardment of unfortified cities, have not been observed during the present war.

Deliberate Attack

A deliberate attack on the defenses of a harbor might be undertaken for the purpose of seizing and occupying the harbor as a base, or of capturing or destroying the naval utilities or the city sheltered behind the defenses. It may take the form of a naval attack or of a combined land and naval attack.

A direct naval attack on fixed defenses might include one or more of the following phases:

a. The reconnaissance and attack of the mine fields.
b. The reconnaissance of the gun and mortar defenses.
c. Attempts to runby.

Reconnaissance and Attack of the Mine Fields

This operation might and probably would be the first phase of the attack, and would be carried out by torpedo-boat destroyers and other small craft; its object would be to locate and clear a passage through the mine field.

Reconnaissance of the Gun and Mortar Defenses

Such reconnaissance would have for its object the determination of the character and position of our gun and mortar defenses. Because of our inability to keep matters of this nature secret, it may be assured that the strength of our fortifications will be known in advance to the enemy, and that as a rule their positions will have been entered upon his charts with sufficient accuracy to preclude the necessity for a reconnaissance, although it might be entered into subsequently to bombardment for the purpose of determining the results of the latter operation.

Attempts to Run By

The deep draft and costliness of modern battleships have rendered this form of attack by capital ships one that is regarded generally as restricted to special localities in which are found the combination of an objective of great value and a hydrography favorable to the assailant. The rapid progress of naval design and the necessity for maintaining a more or less uniformity in tactical qualities in components of the seagoing fleet, will probably continue to result, however, in some naval power finding itself possessed of many second line battleships, and I believe that where the enemy has obtained control of the sea he will have little hesitancy in risking ships of this character in attempts to run by coast fortifications if the objective to be obtained is of material value. The battleships employed at the closer ranges in the Dardanelles operations were of this character.

Combined Land and Naval Attack

This form of attack is in a general case more likely to occur than the simple naval attack. It affords an opportunity of testing simultaneously the strength of each of the co-ordinate elements of the defense. In this form of attack the efforts of the fleet may be confined merely to covering operations in support of the land attack, although it may be expected to avail itself of any developments that may arise during the progress of the latter attack.

Raids

Raids by torpedoboat destroyers, are I believe, the most likely form of naval attack to which our seaboard may be expected to be subject. Practically all of our harbors possess wide channels of approach readily navigable by such vessels. Raids of this character are very likely to take place during the earliest stages of the war or even before the war appears

of approximately 30,000 tons, with a heavy belt armor, of a thickness in the case of the later German battleships of 14 inches. While the 14-inch may be regarded as the present standard naval gun, England has already advanced to the 15-inch in the ships of the "Queen Elizabeth" type, and it is regarded as not unlikely that the near future may witness the general adoption of the 16-inch for naval use. The permissible ranges of these guns as mounted on ship-board are from 21,000 to approximately 25,000 yards. That these ranges may not be considered as improbable of attainment in action is attested by the official report of the recent* engagement in the North Sea, from which it appears that firing was opened at 21,000 yards and decisive results obtained by the time the opposing squadron had closed to approximately 18,000 yards. The same lesson is taught in the recent long-range firing of the *Queen Elizabeth* at the Dardanelles, in which her guns were used at practically the extreme range permitted by the mountings.

In view of these developments in naval design, which have increased materially both the offensive and defensive power of warships, there would appear to be no good reason why the primary gun on fixed mounts in our coast defenses should be less than 16 inches in caliber, particularly in view of the fact that in the case of such defenses an increase in caliber can be secured without the sacrifice of other important desiderata, a condition that does not obtain in naval design. The controlling consideration in selection of the primary gun for coast defense is the necessity for the delivery of a blow of such power as will inflict material, and if practicable, irreparable damage upon the hostile battleship to which it may be opposed.

The 16-inch, 50-caliber gun, has sufficient power, I believe, to answer present requirements, and in addition to afford a margin for meeting future developments in naval armor and ordnance.

I believe that the character of the mount should be such as to impose the minimum practicable limitations upon the development of the potential capabilities of the gun, that is, in the general case the carriage should permit of all-round fire, and of a permissible elevation of the gun to about 30 degrees, affording a maximum range of about 40,000 yards. Such a range, while manifestly too great to be employed against a target that distance to the seaward of the battery, should prove of great advantage, through the use of auxiliary base lines, in contributing to the defense against land or naval operations of a coastal zone 80,000 yards in width.

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* See foot note, page 151.

Progress in naval architecture has been marked also by the segregation of warships into a smaller number of types, which include at present only battleships and battle-cruisers, armored and of approximately equal draft and displacement, scout cruisers of about 5000-ton displacement and 16 to 20 feet draft, torpedoboat destroyers and submarines. For defense against these smaller and unarmored ships, except submarines, the gun required is one combining a high rate of fire with sufficient power to stop or cripple seriously its objective. Our present 3-inch gun, while useful for the defense of the mine fields, is too small to be depended upon to stop a run-by by destroyers. On the whole I believe a gun of approximately six inches in caliber, which is about the largest caliber that can be handled successfully as a rapid fire gun, will meet best the several defensive requirements. Such a gun should be effective against destroyers and scout cruisers, and for the protection of the mine field, and should also prove a useful auxiliary in the attack of capital ships.

Mortars

Seacoast mortars as employed in our service possess several distinct advantages and some marked disadvantages. They are capable of all-round fire; they can not be silenced by naval bombardment; and their fire is directed against the most vulnerable portion of a warship. On the other hand they are wholly dependent upon an accurate fire control system; great precision of prediction is required because of the length of the time of flight of the projectile; their ranges are limited as compared with those of large modern caliber guns; and the necessity of employing zone fire and the impracticability of forecasting the atmospheric conditions that will be met by the projectile throughout the higher portions of the trajectory, are conditions that complicate to such an extent the problem of the development of an effective fire control system that in spite of much study and extensive experimentation but little progress in that direction has been made during the past ten years. Our target practice with mortars, unlike that with guns, has been conducted under conditions that can not be expected to obtain in action, and the high percentages of hits obtained on moving targets has resulted, it seems to me, in causing some officers to accord to mortars an undue weight in our defensive scheme.

Passing to the question of the caliber of mortar to be emplaced in future, it may be said that the 12-inch mortar possesses the disadvantage of requiring two types of projectiles, the 1046 and 700 lb., and that the 700-pound projectile, which has to be employed throughout about 60 per cent of the field of fire has comparatively small destructive power. The employment of the 16-inch mortar, however, would permit of covering the entire field between 3000 and 23,000 yards with a single projectile of 1660 pounds, having an ample perforating and destructive effect in all zones.

Anti-Aircraft Guns

The rapid development in recent years of aerocraft renders it necessary to furnish coast fortifications with some means of defense against an aerial attack. To meet this need the Ordnance Department has designed a three-inch gun to be mounted on a carriage permitting all-round fire and elevations from zero to eighty-five degrees.

DISPOSITION OF ARMAMENT

The selection of sites for primary armament for the defense of a given locality is influenced not only by certain general considerations, which are of a more or less conflicting character, but also by the special conditions which apply to the particular locality, as the local hydrography and topography, and the geographical position of the locality with respect to possible bases of the enemy.

The general considerations which will influence a decision upon the selection of a site for the primary armament include:

a. This armament should be located sufficiently in advance of the utilities it defends to preclude damage to them from naval bombardment conducted from water areas lying beyond the effective range of the defenses. The maximum range of naval ordnance as mounted at present is approximately 25,000 yards. It seems not unreasonable to assume that increase in the power of naval guns and improvements in naval mountings may extend this maximum range to 30,000 or even 35,000 yards. While the latter range will be exceeded by the projected 16-inch guns, the difference in the areas of the target presented by a compactly built city and by a battleship is such that it is desirable that the primary guns be located well in advance of the city they defend, preferably at a distance of ten miles and upward therefrom.

b. It should be located on such sites that a maximum sector of deep water can be covered at effective ranges.

c. At a locality that is the site of a naval base or that is likely to be utilized as a harbor of refuge for naval vessels, the armament should be so disposed as to protect our fleet when debouching in column from the harbor under the fire of a hostile squadron.

d. Isolation of batteries should be avoided in order to prevent the reduction of batteries in detail.

e. The armament should be so dispersed as to preclude an effective concentration thereon of hostile naval fire.

f. The sites selected should favor concealment.

g. In so far as may not be inconsistent with other important considerations, the site selected should be one that through the provision of a small infantry force can be made secure against landing parties.

h. The site selected should favor the installation of effective fire control and searchlight systems.

In the case of mortars it may be said that in addition to the considerations mentioned above it is desirable that mortars should be so located that the main channel of approach for armored ships will traverse the minimum number of zones. I do not believe, however, that this consideration should govern to such extent as to cause the mortars to be emplaced in retired positions, or in those unfavorable to effective fire direction.

The primary functions for which rapid-fire guns are needed, namely, for the protection of mine fields and for defense against raids by destroyers, will usually confine the selection of their sites to rather narrow limits. These guns should be located on low sites, close to the shore line, in positions affording wide areas of fire, and, if practicable, at a sufficient distance from the primary armament to avoid destruction by shell directed at the latter. Guns intended primarily for defense against destroyer raids should be located preferably at a contracted part of the channel.

EXTENT OF ARMAMENT

While many attempts have been made to establish theoretically the ratio that should obtain between the number of guns mounted ashore and the number likely to be found in the attacking naval force, I believe that it is the general concensus of opinion that in practice too many conditions enter the problem to permit any rule of this character to have a wide or rational application. The strength and determination of the attack may be expected to depend largely upon the value of the objective to the enemy, and upon the extent to which he is willing to sustain naval losses for its attainment. The character of the water approaches will limit the number of ships that can be deployed usefully against the shore defenses. I think it safe to assume that the projected 16-inch gun, or a battery of four 16-inch mortars, may be expected to dispose of a single ship that approaches within ten or twelve thousand yards of the armament.

AMMUNITION

The policy followed heretofore as to reserve seacoast ammunition has contemplated the accumulation of the so-called two hours' allowance, an allowance assumed to be sufficient for the duration of a single engagement. Recognizing the fact that the allowance provided under this policy would be inadequate, the War Department has recently adopted the policy that the allowances for the several calibers should be:

a. For guns in continental United States, except guns of 8-inch caliber and upwards on inner lines of defense, allowances equal to one-half the accuracy life of the respective calibers; for mortars, except on inner lines of defense, an allowance equal to one-fourth the accuracy life.

b. For armament of 8-inch caliber and upwards on inner lines of defense in continental United States, allowances equal to one-half those for outer lines.

c. For guns in the insular possessions and on the Canal Zone, allowances equal to the accuracy life of the respective calibers; for mortars, an allowance equal to two-thirds the accuracy life.

FIRE CONTROL

The great ranges at which coast artillery armament has to be employed and the fact that the targets presented thereto may be expected to be usually in motion, preclude effective use of coast armament without an accurate fire control system. The greatly increased ranges to be obtained with the projected primary armament necessitate the employment of longer horizontal base lines than have been used heretofore. It is my belief that whenever practicable, the base lines for this armament should be about 4000 yards in length, and that wherever the fire of the armament can be employed with advantage at extreme ranges to cover distant beaches, flank observing stations should be provided for this purpose. The base end stations should be of an inconspicuous character, and several auxiliary emergency stations, consisting of a pier mount for an azimuth instrument, cut in on the main base line cable, should be provided on each end and on the prolongation of the base line. A self-contained horizontal base instrument should be provided for emergency purposes at each battery.

POWER PLANTS

Power is necessary in the coast artillery service for searchlights, and for energizing mine and fire control cables, and is desirable for the operation of ammunition hoists, for emplacement lighting, for fire and lighting circuits on gun carriages, and for the retraction of disappearing guns. The type of unit provided at present in our service for battery and searchlight use, is the 25 k.w. set, the cost of procuring which is approximately $4000 per set, but the cost of installation varies from $3000 to $12,000 per set, depending upon local conditions.

SEARCHLIGHTS

The 60-inch searchlight is the adopted type in our service. For the purposes of estimate it has been assumed as a general rule that the number of searchlights provided for any locality is sufficient to provide two searching lights for each fort command and an illuminating light for each fire and mine command. As, however, the actual number and the location of the lights can be determined satisfactorily only as a result of actual experiment, the general practice has been to determine the matter by trial with portable lights before finally installing the searchlight project for the locality.

It has been found that too many lights, or the faulty location of those provided, will prove a decided disadvantage to the defense.

The cost of the 60-inch lights, including both projector and generator, is approximately $8000. The cost of installation varies with the locality, and while in some cases it has been as low as $5000, in others it has amounted to as much as $20,000. In view of the high cost and the disadvantages of exposure often attendant upon installing advanced lights in fixed positions, it would appear that an advantageous arrangement in some cases would be the mounting of advanced lights and their generators upon movable trucks.

Other considerations to be fulfilled in so far as may be practicable in the location of searchlights are:

a. The searching light should be located well in advance of the line of defense, and so dispersed as to cover all avenues of approach.

b. The illuminating lights should be at the extremities of the base lines and on the flanks of all the elements they are to serve.

c. Illuminating lights should have not less than 150 yards lateral displacement from the nearest elements they serve, and if practicable, at least 20 feet vertical displacement therefrom.

d. While it is desirable that illuminating lights should be higher than the elements they serve, this condition should not govern to such an extent as to result in the installation of lights on conspicuous structures or on the withdrawal of the lights from the shore line.

Experience indicates that in good weather the 60-inch light will afford an illumination of large targets satisfactory for horizontal base work up to 6000 to 7000 yards, although in some localities where atmospheric conditions are unusually favorable, such distance may be materially exceeded.

SUBMARINE MINES

Submarine mines are needed to preclude a run-by at times unfavorable for the effective employment of the gun defenses, that is during fogs or on nights on which searchlights can not be used to advantage. For harbor defense it is necessary that mines should be of the anchored, shore-controlled type, instead of the floating, mechanical type, in order to preclude danger to friendly shipping.

The controlling principle in locating the mine field is that its location shall be such as to permit of its being covered effectively by gun fire and well illuminated so as to prevent the opening of a passage-way through the mine field. An observance of this principle confines the mine field to a position within approximately 4000 yards of the defenses. Wherever mortars are installed it is desirable that the mine field, or at least the outer line of mines, be located beyond the interior range of mortar fire.

Local considerations, such as the character of the channel to be defended, and the strength of the current, influence the choice of the site for the mine field at any particular locality.

In the selection of sites for mine buildings the most essential consideration is the location of the casemate in a protected position. The location of the casemate also should be preferably in rear rather than on the flank of the field, and, if practicable, not in close proximity to a battery or other conspicuous element of the defense. The storehouses, cable tanks, and loading rooms should be convenient of access to each, and to the wharf, and so located with respect to each other that each successive step in the preparation of a mine for planting will bring the material nearer the wharf.

An unobstructive passage-way has to be left in the mine field for the ingress and egress of friendly vessels. It has been the practice in our service to have this passage-way selected by a naval officer, subject to final approval by the Joint Board.

BOOMS

The most effective means of defense for precluding a run-past into interior water areas by destroyers, is by the provision of some form of boom defense or other physical obstruction, and the development of submarines demands that wherever these inner areas are favorable for the operation of such craft, the boom should be supplied with some form of underwater net for preventing their entrance. Large vessels, of course, may be employed for cutting an entrance through such obstructions, but even in that event the opening will only be temporary, and it will be much easier of defense by rapid fire guns than an unobstructed entrance.

A MODIFIED TIME-RANGE BOARD

DEVISED BY CAPTAIN CLIFFORD JONES, COAST ARTILLERY CORPS

DESCRIPTION

The essential modifications of the time-range board from the standard design are as follows:

a. The board proper is made smaller, about 4 by 6½ feet, so that it may be installed in the plotting room. No loss of accuracy is entailed by decreasing the size since the lines are placed on the board by snapping a chalk line through the points plotted on the board rather than drawing a coarse chalk line along a ruler. The device for snapping the chalk line consists of a string stretched as shown in Fig. 3. This method of placing fine lines on the board was suggested by First Lieutenant Robert E. Guthrie, C. A. C.

b. Only the 30-second time lines are drawn. The range lines passing through 0 and the time line one minute from the right edge, are red lines (in Fig. 1, shown by dot-and-dash lines).

c. An additional time scale *C D*, Fig. 1, is placed above the T-square and flush with its front face. *C D* is graduated into 30-second time lines which are subdivided into 10-second lines.

d. The T-square is constructed as shown in Figs. 1 and 2.

It is supported on castors running along the top edge of the board and is prevented from slipping forward by a cleat on the back side. It slides as near the board as possible, being held from actual contact by very thin shoes at top and bottom.

The leg is bevelled about two-thirds its width to a thin edge on the right and graduated to 10 yards, the graduations being carried over the edge to prevent parallax in reading.

The hundreds of yards are stenciled as shown, thus requiring the thousands only to be written on the head of the T-square at the place marked *E*. There is no sliding pointer along the edge.

The pointer *F* is stenciled on the T-square at a distance from the right edge of the leg equal to the time interval representing the average time required to set the range and fire the gun reckoned from some convenient starting time.

e. Arrange the time-interval bell so that in the plotting room it will ring one stroke 10 seconds after the observing time and two strokes at 20 seconds after this time, with the regular three strokes every thirty seconds. If this is not practicable, a stop-watch placed in a convenient position and running with the time-interval bell may be used.

OPERATION

Two additional members are added to the range section, Nos. 8 and 9. No. 8, as the corrected ranges are called from the range-correction board, plots them on the time lines beginning at the left and drawing a line through the last two plotted points and extending it to the next time line, writing the thousands of yards at *E* and plotting opposite the correct hundreds and tens read from the T-square.

The range he receives is the corrected range for the next three bells; when this bell strikes, he checks with a chalk mark the long line on the scale *C D* which lies in prolongation of the time line upon which he has plotted the last range. At ten seconds thereafter he checks the first short line to the right and at twenty seconds, the second short line beyond, starting again with the long line on the next three strokes of the time-interval bell. When the plot crosses the top red line it is at once transferred to the bottom red line, increasing the thousands of yards by one as soon as the readings are to be taken across the line, and vice versa when the track crosses the bottom red line, the old plot always being continued until the new one is ready for predictions. The same applies when the red time line is reached, transfer then being made to the left of the board.

No. 9 wears the head set connected with the range-deflection recorders at the guns. (One man acts as both range and deflection recorder.) He transmits the deflections as they are announced and, upon the range-deflection recorder repeating the command "trip" to him over the telephone, he sets the T-square so that the pointer *F* lies between the last checked line on *C D* and the next line to the right (its exact position being determined by the lapsed time since the last bell) and reads the range to the range-deflection recorder from the T-square where it intersects the plot of the range. The range is also set on the mechanical range transmission device which gives check on the telephone.

ADVANTAGES

The advantages of the board being in the plotting room are as follows:

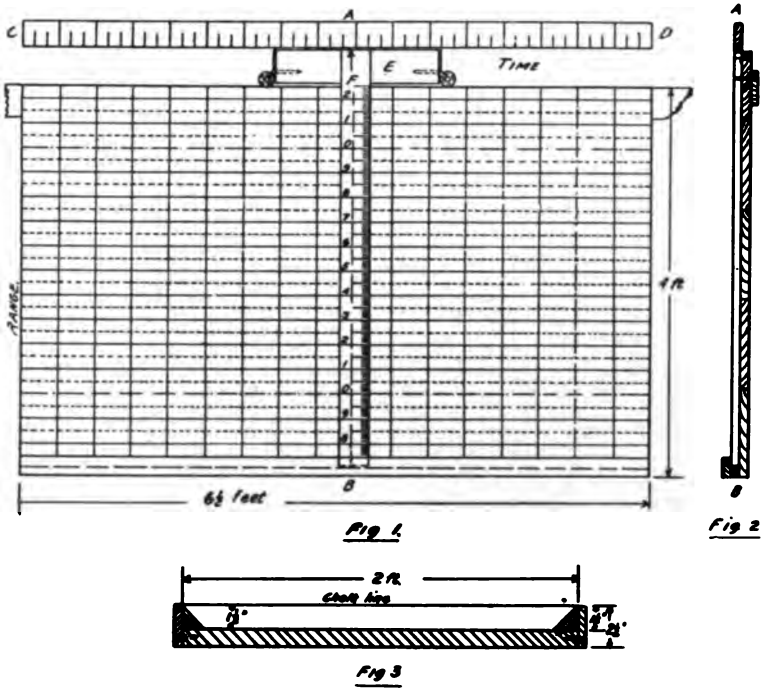

Fig 1 Fig 2

Fig 3

TIME-RANGE BOARD

a. Being away from the gun platform, both the work of plotting and reading will be done more accurately. This is especially so as the work is done under the immediate supervision of the range officer.

b. In case the target is turning, the plotter can indicate same to No. 8 who can plot his course accordingly.

c. If there are errors in the work of the range section, it at once becomes apparent to the plotter.

The advantages of the modifications of the board are the increased simplicity of operation, there being only one operation to reading the range in place of two and the greatly decreased amount of labor in writing in numbers and having to erase same on the leg of the T-square. Also the accuracy of setting of the T-square is greatly increased as it is practically impossible to make an error of over five seconds and a trained operator should rarely be more than two seconds out.

This board has been tried out for some time at Battery Selfridge and found satisfactory in all respects.

ELECTROLYTIC ALTERNATING CURRENT RECTIFIERS

By Captain ADELNO GIBSON, Coast Artillery Corps

The writer has found it convenient and desirable on several occasions in his coast artillery experience, to be able to construct a cheap, easily made, and effective device for changing alternating current to direct current. It is believed that others will find the device herein described, of practical value for emergency use.

The first part of this article makes a brief survey of the means available for changing alternating current to direct current. The latter part describes an electrolytic rectifier which the writer has found of use in emergency cases.

Methods of Changing Alternating Current to Direct Current

When electrical energy is transmitted a considerable distance, as is often the case in the Coast Artillery, it is desirable to use an alternating voltage of a relatively high value in the transmission, for the purpose of saving copper and then at the receiving end, for purposes of convenience in use, to change the high alternating voltage to a direct voltage of 120 volts or less.

This change to a direct voltage may be brought about by three general methods:

1. Mechanical, including:
    a. Rotary converters.
    b. Motor generators.
    c. Electro-magnetic rectifiers.
2. Mercury-arc rectifiers.
3. Electrolytic rectifiers.

For large values of current, the rotary converter or the motor generator is used. The rotary converter has the higher efficiency but less flexibility. The motor-generator is generally used in the Coast Artillery.

For relatively small values of current, as in charging the 30-volt telephone storage battery, the mercury-arc rectifier is used in the Coast Artillery and largely in commercial practice for similar service. With a glass tube the mercury-arc rectifier has a maximum capacity of 40 amperes on the direct current side and with a steel tube this may be very much increased.

The efficiency of the rotary converter runs as high as 93 per cent (not including transformer losses) while 85 per cent is a high efficiency for the motor-generator. The efficiency of the mercury-arc rectifier depends upon the voltage of the direct current side, since there is practically a constant drop of fourteen volts in the rectifier tube. The efficiency, therefore, increases with the increase of voltage on the direct current side.

For charging six-volt storage batteries, used on motor boats, automobiles, etc., from an alternating current system, either a small mercury-arc rectifier or an electro-magnetic rectifier is used.

The electro-magnetic rectifier consists essentially of a polarized relay acted upon by two alternating-current magnets so that the armature vibrates in synchronism with the alternations of the current, reversing the connections of the storage battery every alternation and thus causing the current to flow through the battery in the same direction all the time. The current delivered to the battery is a pulsating but *undirectional* current. Due to the difficulty of avoiding sparking at the contacts, this type of rectifier is limited in capacity to about twelve volts and sixteen amperes on the direct current side. The efficiency runs as high as 50 per cent.

THE ELECTROLYTIC RECTIFIER

The electrolytic rectifier, sometimes called a Nodon Valve after Albert Nodon who conducted a research into the characteristics of the valve and whose data is accepted as standard, depends for its effect upon the fact that certain electrolytic cells will allow a current free passage through them in one direction but offer a very high resistance to the passage of a current in the opposite direction.

The history of the rectifier is outlined as follows in a paper read by Albert Nodon before the International Electrical Congress at the World's Fair, St. Louis, 1904.

> Buff discovered in 1856 the property which is possessed by aluminum, when dipped in a salt solution, of allowing a free flow of current in one

direction, but of stopping the flow when in the opposite direction; Ducretet utilized this property in 1874 for constructing an alternating current rectifier; Leo Gratz studied a particular method of setting up the apparatus; Carl Liebenow investigated the electrolyte; Pollack made a number of investigations upon the valves and obtained the first results of industrial value.

In 1899 Albert Nodon reviewed what previously had been done and conducted a series of researches at the Sorbonne and the Collège de France, with a view to throwing light upon a problem as yet little understood.

These researches of Nodon constitute the most extensive and authoritative investigation of electrolytic rectifiers of which the data is available.

The essentials of the valve, as stated by Nodon, are a metallic cathode* of small surface, an anode of large surface and an electrolyte, which last is generally a salt solution.

In theory, according to Nodon, the anode is without influence upon the valve effect, if its relative surface is sufficient. In practice, however, three substances have been found satisfactory as anodes, viz., lead, polished steel, and carbon. Lead is the most satisfactory of the three.

For the cathode, the only satisfactory substance is pure aluminum or aluminum alloyed with a very small proportion of a foreign metal.

It will be found in general, that commercial aluminum contains too large a percentage of zinc or other foreign matter to have the required rectifying effect. The aluminum cups and other aluminum articles of the mess equipment will be found to contain too great a percentage of zinc to allow of their being used in constructing a rectifier.

For the electrolyte, Nodon obtained the best results from a concentrated solution of neutral ammonium phosphate. This is a relatively expensive chemical and since sodium bicarbonate gives almost equally good results, is relatively cheap, and is found in most households, it will generally be found desirable to use a concentrated solution of sodium bicarbonate as the electrolyte.

The area of the anode should be as great as can conveniently be used in the cell. The area of the cathode should be relatively small, for it is upon the surface of the cathode that the high resistance substance, (aluminum hydroxide) is formed that tends to prevent the current passing from the

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*The writer has reversed Nodon's use of the term anode and cathode to conform to the generally accepted definition of these terms.

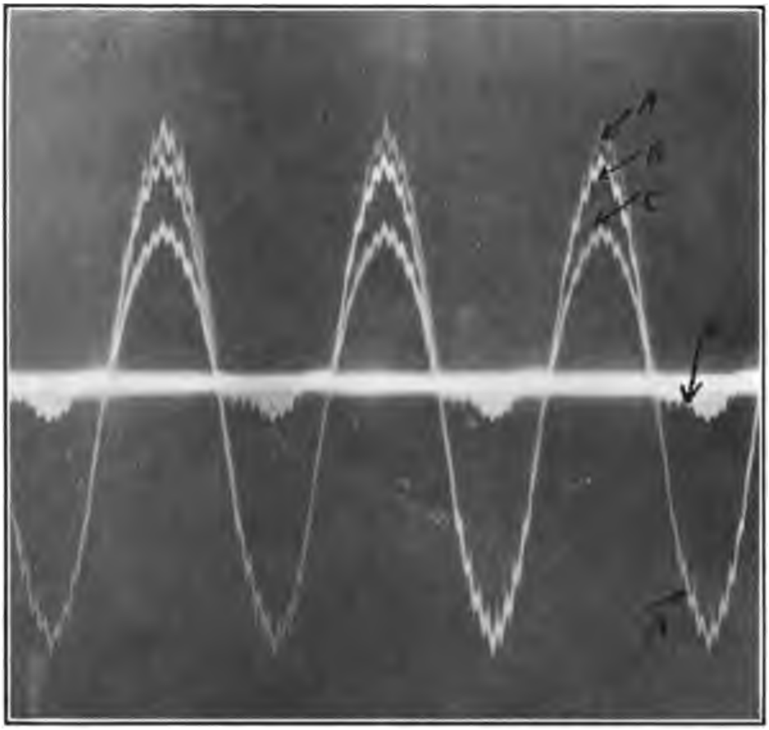

Fig. 2. 1859
An oscillogram of the single valve shown in Fig. 1. A, total a. c. voltage; B, drop across valve; C, rectified current; D, leakage through the valve

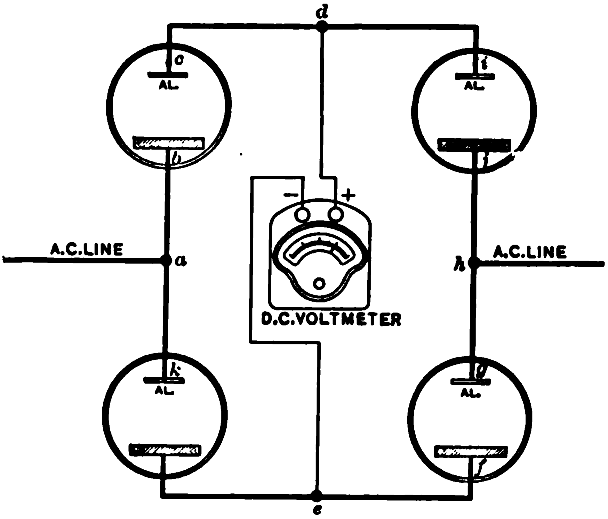

Fig. 3. 1860
A typical 4-valve rectifier unloaded

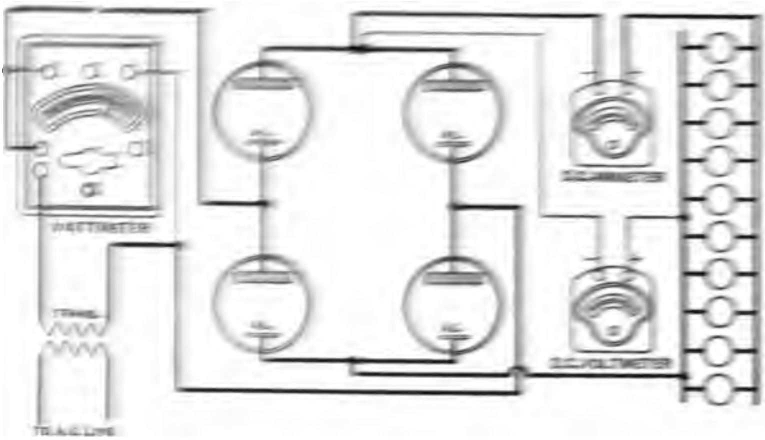

Fig. 4.
A TYPICAL 4-VALVE RECTIFIER CHARGER

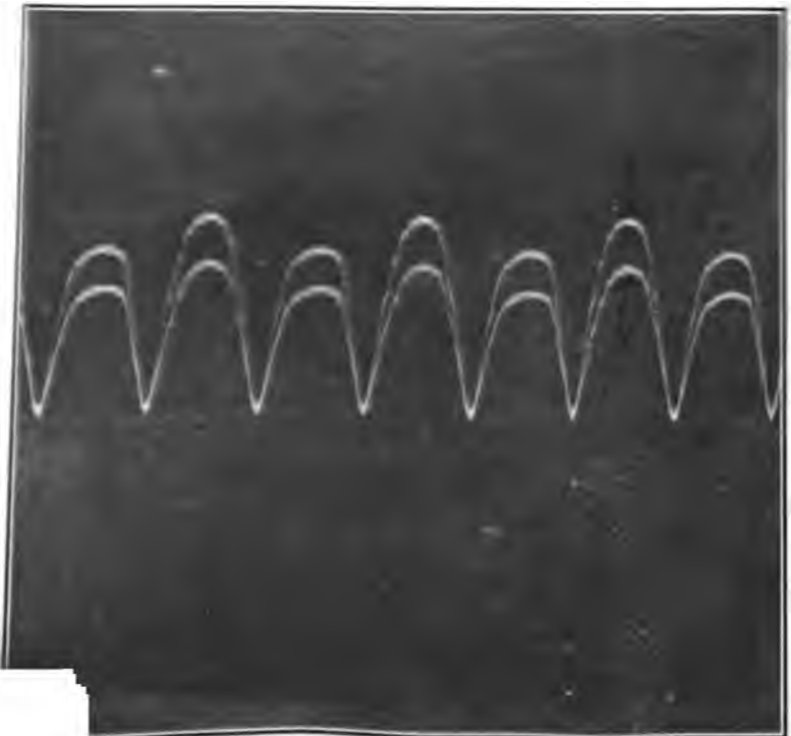

Fig. 5.
OSCILLOGRAM OF THE 4-VALVE RECTIFIER SHOWN IN Fig. 4. A, DROP ACROSS CELLS;
B, RECTIFIED CURRENT

1883

By keeping in mind the fact that the current cannot pass from aluminum to lead but can pass in the reverse direction, it will readily be seen that the current passing through the lamps is direct current and the lower connection of this valve diagram is always positive regardless of the direction of the alternating current at any particular instant.

Fig. 5 is an oscillogram taken from a rectifier connected as in Fig. 3. The undirectional but pulsating character of the rectified current is here clearly shown. Various other arrangements of the rectifying valves are shown in the succeeding diagrams. The functioning of any one of them can readily be analyzed by keeping in mind the fundamental fact that current can pass from the lead to the aluminum but not from the aluminum to the lead.

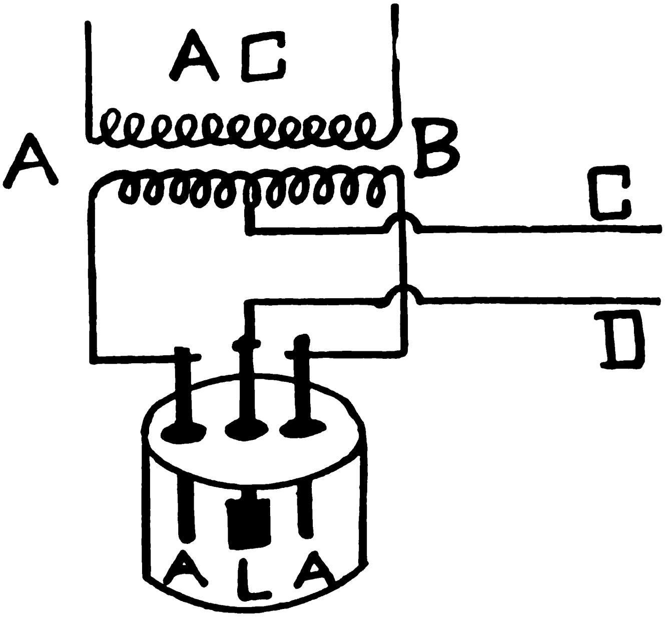

FIG. 6.

A METHOD OF RECTIFYING BOTH HALVES OF THE WAVE BY USING A SINGLE CELL

In each diagram the cathode is aluminum and the anode either lead, polished steel, or carbon.

Fig. 6 shows a method of rectifying both half waves by means of a single cell or valve.

Fig. 7 shows a method of rectifying both half waves by means of three valves.

Figs. 8 and 9 show methods of rectifying one-half of the wave.

Fig. 10 shows a method of using the valve on a two-phase or a three-phase circuit.

Fig. 11 illustrates an experiment performed by Mr. C. P. Frey of the Weston Electrical Instrument Co., to illustrate the effect of the coat of aluminum hydroxide on the aluminum plate. The valve was connected as in Fig. 1. Before the sharp point of the iron rod touched the aluminum plate, the lamp glowed moderately and the direct current ammeter showed that direct current was flowing. When the point of the rod was allowed to touch the aluminum plate, bubbles of gas arose, the lamp burned brightly, the reading of the alternating current ammeter increased while the reading of the direct current ammeter fell to zero. The experiment tends to show that there is a high resistance film formed on the aluminum plate which prevents the flow of current from aluminum to lead, and when this film is punctured the current can flow freely in either direction.

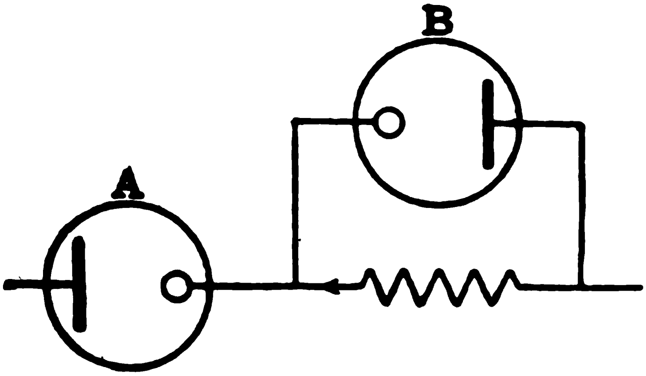

FIG. 9.
SIEMENS GROUPING

ELECTROLYTIC CONDENSER

By making both the anode and the cathode aluminum plates, the valve becomes a condenser of relatively large capacity.

For experimental purposes in a testing laboratory, or wherever large capacity condensers are needed, this type of condenser answers all purposes, is indestructible, very cheap, and affords capacities greatly in excess of any obtained from expensive commercial apparatus.

The jars should be set in running water or in a large vessel of water for the purpose of carrying off the heat which represents the I^2r loss in the rectifier. A fan may be used instead of the water for cooling. The efficiency of the rectifier decreases rapidly with an increase in temperature. Nodon recommends that the temperature be kept below 100° F.

When 110 volts alternating current are impressed across the rectifier, sparking tends to take place between the aluminum plates and the surface of the liquid. This may be prevented by: (a) using oil on the surface of the liquid; (b) connecting a rheostat on the alternating current side; (c) wrapping manson tape or other insulating material around the aluminum plates to a point about ½ inch below the surface of the liquid.

When first using a rectifier, it is necessary to place a rheostat on the alternating current side to limit the current. After the coating of aluminum hydroxide is formed, this rheostat may be dispensed with and need not be used for starting thereafter unless the rectifier should stand unused for a long period.

EFFICIENCY OF THE RECTIFIER

Nodon states* that The Mors Company of Paris constructs standard sizes between 1 and 100 amperes at 110 volts whose operation is regular and constant. The guaranteed industrial efficiency of these valves varies between 65 and 75 per cent. A home-made rectifier will probably have an efficiency of not more than 50 per cent.

This efficiency may seem low but, when it is considered that with commercial apparatus for charging ignition and lighting batteries an efficiency of 50 per cent is very high, the efficiency of the rectifier is very good.

An additional point of great importance is, that with the electro-magnetic or mechanical rectifier and with the small mercury-arc rectifiers, the direct current voltage is always well under 30 volts while 80 volts are readily obtainable on the loaded direct current side of the electrolytic rectifier. For example, there is no small cheap rectifying device purchasable that will charge the 30-volt telephone storage battery used in the Coast Artillery (by cheap, is meant costing

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*This statement was made in 1904 and, of course, applied to a company and to conditions at that date. The statement is given to show that this type of rectifier has been standardized and sold commercially and that a relatively high efficiency is obtainable outside the laboratory.

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A single cell Nodon valve inserted in the line with the aluminum plate connected to the positive pole of the battery would protect the battery and charging apparatus as effectually as would an underload or a reverse current circuit breaker.

In connecting up the four-valve rectifier, an interesting phenomenon results. When the valve is unloaded, the rectified direct current voltage is higher than the alternating current voltage. Upon first consideration, it would seem that the alternating current voltage should be the higher with a ratio of alternating current voltage to direct current voltage of 707 to 636, i.e., the ratio of the mean effective value to the average value. An explanation of the reason for the direct current voltage being higher is given in the following extract from a report of the General Electric Company's research laboratory.

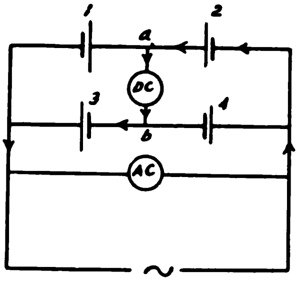

FIG. 12.

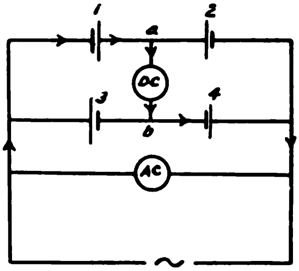

FIG. 13.

1869

It has been shown by suitable tests that the capacity between the aluminum plate and the electrolytic is very large, the dielectric consisting of the thin film formed by the current action. This capacity is approximately one microfarad for every seventeen square inches immersed.

When current passes through the cell from the iron to the aluminum, it is evident that on account of the small resistance offered the electricity stored is negligible; but when a reversal takes place a static charge is accumulated, the amount depending on the alternating current voltage.

When the current flows as shown by the arrows in Fig. 12, it passes through cells 2 and 3 only, cells 1 and 4 being charged to the potential of the alternating E. M. F. Upon reversal of the current the path is as indicated in Fig. 13, so that the charge upon 1 and 4 tends to increase the current through the meter. This, of course, is repeated every half cycle, and becomes appreciable only when the direct current is very small as is the case when a high resistance volt-meter only is connected in the circuit.

The results of a few tests made with plates of iron and aluminum with immersed area of twelve square inches, using a bicarbonate of soda solution, were as follows.

A direct current voltmeter having a resistance of 15,000 ohms, was connected in circuit between a and b and the alternating current line voltage gradually increased from 20 to 192 volts.

RANGE TRAVEL SET-FORWARD DEVICE

By Captain HENRY W. BUNN, Coast Artillery Corps

The device consists of a chart mounted on a drum the axle of which, projecting at either end, revolves in a suitable frame.

The chart on the drum is divided by horizontal and vertical lines into squares. As the drum revolves, one horizontal series of squares at a time is revealed through a slit in the frame. Take one such horizontal series for example (Fig. 1). The plotter has just called out "Range 12,500," "Travel 145" (i.e., travel during last observing interval). The operator of this device turns his drum until on the left square seen through the slit appears the numeration "12,400 to 12,800." Observe that below the horizontal series of squares seen through the slit is a corresponding horizontal series of squares (sta-

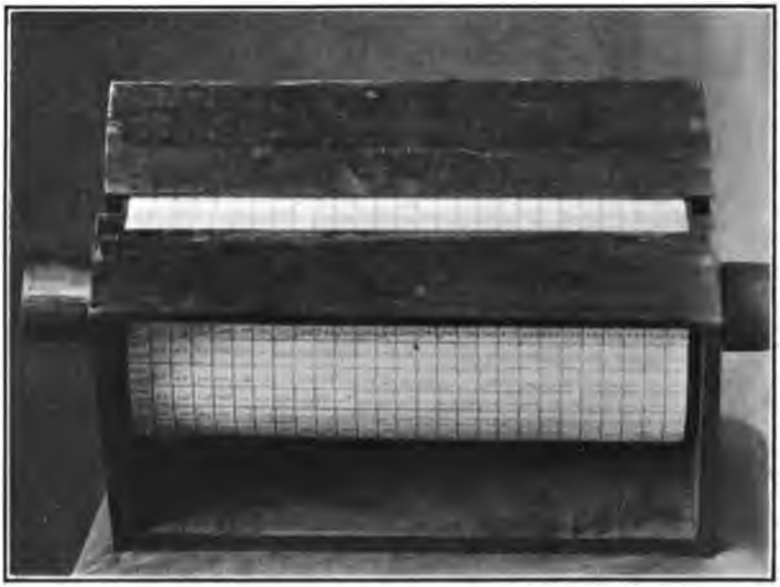

Fig 1. 1878

tionary) pasted on frame. The operator of the device glances along the stationary series of squares until he reaches square "150." He then reads from the square on the revolving drum just above "260," which is the travel during observing interval plus the time of flight corresponding to range 12,500. After a little practice, he will interpolate (the method being obvious), and, instead of calling "260," will call "255."

Of course, by making the device large enough, the stationary series of the frame could be made to exhibit successive travels during the observing interval at minute intervals from 0 to ∞ and the drum could be made to exhibit corresponding travels during observing interval plus the time of flight for minute increments or decrements of range between the inner and outer limits.

The board as constructed for Battery Revere exhibits on the stationary scale travels during observing interval from 50 to 300 yards at 10 yards interval, and the drum exhibits the combined travels for groups of ranges, each group comprising 400 yards. The greater accuracy to be obtained by more minute subdivisions is offset by the greater speed obtained by the construction adopted. The operator of the device is trained to interpolate so as to obtain very accurate results.

The device above described is the invention of Second Lieutenant Claude M. Thiele, C. A. C., and is used at Battery Revere, Fort Flagler, Washington.

CLEANING MINE CASES

A Method Employed at the Coast Artillery School

By 2nd Lieutenant CLARENCE B. LINDNER, Coast Artillery Corps

At a recent inspection of mine cases large spots of rust were found on the interior of some of the cases stored in the mine storehouse. Some of this rust was very bad and appeared to have formed on slag left on the interior of the case during manufacture. Its removal was attempted by using scrapers; but it was soon found that this was impracticable, and the following method was used with great success.

A plug-proper was bored and tapped and an inch and a half shaft, one foot long, inserted as shown in Fig 1.

On the mine wharf, convenient to the derrick, two cable-reel jacks (Fig. 2) were bolted down the proper distance apart. On one of these jacks a board was bolted, having a U-shaped groove at the top reinforced with iron as shown in Fig. 1. The maneuvering ring of the mine case rested in this groove and supported one end of the mine case during cleaning. The plug-proper, prepared as described above, was screwed into the other end of the case and the shaft rested on the cable-reel jack, thus supporting the other end of the case. This jack could be screwed up or down.

About one hundred and fifty pounds of large gravel were put in a case, the plug screwed in, an iron washer put on the shaft, and by means of a sling the case was picked up by the derrick and lowered onto the two supports described above.

The case with the gravel in it was revolved by an electric motor and a belt from ten to twenty minutes, depending on the condition of the interior. During this time the plug end of the case was raised and lowered by the screw on the cable-reel jack, thus allowing the gravel to work in both ends as well as in the middle of the case. After revolving the required time, the plug was removed and the case picked up by means of the maneuvering ring and emptied.

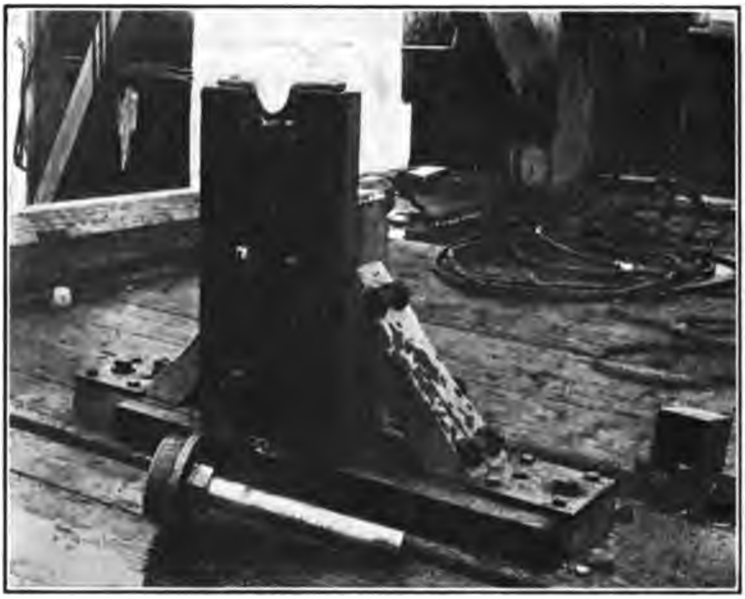

FIG. 1. 1871

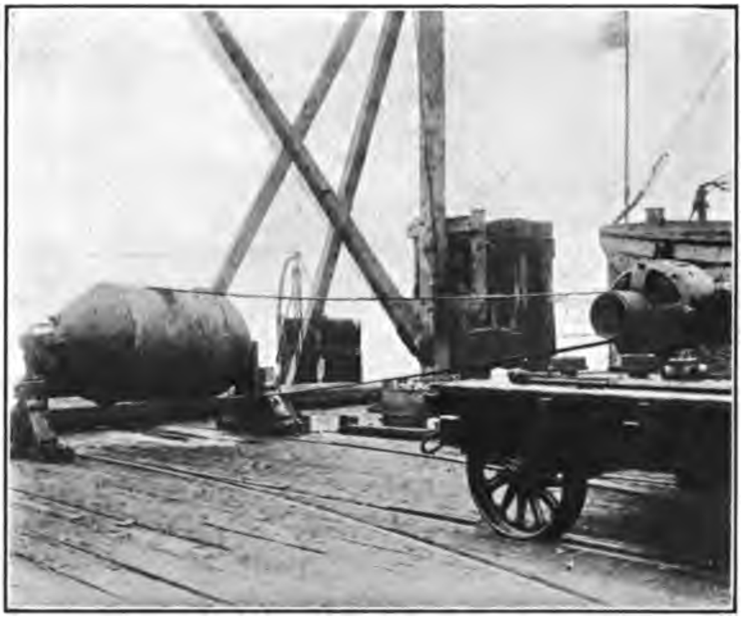

FIG. 2. 1872

Before putting a case, cleaned as described, back in storage, its interior was given a coat of tar oil, a long handled brush being used. For examining the interior of cases, an incandescent lamp lashed to the end of a stick was found useful.

PROFESSIONAL NOTES

MOTOR TRANSPORT IN CAMPAIGN

Prepared by the War College Division, General Staff Corps, as a Supplement to the Statement of a Proper Military Policy for the United States

INTRODUCTION

The past 15 months of war have resulted in verifying in every respect the predictions of military writers of late years. All pointed out that nature and science would be called upon to serve mankind in many practical ways, and that achievements then (at the time of writing) in their infancy would, under the stress of war, develop into aids which would be found to be of far-reaching importance.

Such of these predictions as relate to the use and application of motor transport have been found to be correct, and this is shown primarily through its improvement and development, but lastly by the fact that it has become absolutely essential to the efficient prosecution of a campaign.

GENERAL CONDITIONS OF EMPLOYMENT

Modern weapons of offense and defense, such as large-caliber mobile artillery, the machine gun, and the aeroplane, have exercised a marked and direct influence on combat in general. Strategy has been affected by the altered conditions affecting the battle, and even the conduct of an action has been influenced. Along with the use of motor transport, which altered the aspect of warfare, both in countries with good highways and in those which lack them, comes a speeding up of the rate at which military operations can be conducted. The strategic mobility of troops has been increased, and this fact will bring about greater ease in the grouping of forces for the battle.

Indirectly they promote "the independence of the troops of their lines of communication, by facilitating the bringing up of supplies and by creating possibilities for concentration and movements which did not formerly exist. Commanders acquire thereby greater freedom of action."

It must not be assumed, however, that the methods of warfare have been revolutionized through the use of motor transport. When the war is over and the newspapers have ceased to announce in big headlines the wonderful achievements of this type of transport, we shall undoubtedly find there are many limitations to be placed on its use. However, there is no doubt that it has aided in a remarkable way the supply and transport of troops.

What may have been found feasible on the western front might not have been found possible in the plains of Galicia and Poland. Difficulties connected with the repair and supply of fuel have limited the use of this transport in a number of cases, but no definite rule can as yet be deduced from the special cases which are set forth in the press and in the popular magazines.

Various Types Employed

The history of the present war indicates conclusively that all attempts to employ a special type of car or truck for service have ceased. The type of truck or car ordinarily in use in the particular theater of operations before hostilities offers the most adaptable and suitable transport for war in that theater.

In France no attempt has been made to use any particular type of either automobiles or motor trucks, but the Government has taken what it could get from the principal manufacturers. As far as possible, endeavor is made to have all the motor trucks of each army the same make.

Various American trucks have been found excellent in every way, and a light chassis for ambulances is rendering the best service. These can go where heavier vehicles in many cases could not pass, and where they would only encumber the road.

It seems to be generally conceded abroad that the trains corresponding to our field and combat trains should be horse drawn, while the division, corps, and army trains are best constituted of motor transport. There are to be found some exceptions to this rule, but, generally speaking, the official reports are a unit in this respect.

Motor Trucks—Uses, Capacity, Personnel

The corps trains, for instance, in the French organization correspond to our divisional trains (supply, ammunition, sanitary, and engineers' trains), have in part been replaced by motor vehicles. The supply train still remains animal drawn, with the exception of that part of it engaged in taking forward beef from the slaughtering points to the regimental train (their meat wagons). The ammunition train remains equipped with animal-drawn caissons. As previously explained, these caissons must often pass off of the metaled roads and travel through fields so as to supply combatant units. Ammunition is pushed up much closer to troops by auto trucks than was the case in previous wars. The étape or link therefore to be covered by the caisson is not as great as it used to be. However, the expenditure of artillery ammunition is much greater than was ever contemplated, and the saving of the road space in the length of the étape or link has been more than compensated for in the additional number of trips these vehicles must make. The very large caliber guns are not assigned to the corps, but are part of the army artillery. The size and weight of the ammunition of some of these guns make it practically necessary to replace their ammunition by motor trucks. These guns themselves are so heavy as to make it necessary to carefully pick out the ground over which they are taken into position. They are not mobile in the sense of the guns with the corps and some of the lighter type of heavy guns with the army. Their position is also such as to make their resupply in ammunition much simpler than the smaller guns.

The sanitary trains have been greatly supplemented by the attaching of automobile ambulances directly to these trains, in addition to the animal-drawn units. Although not known definitely, it is believed that some of

were only a few of the auto trucks that the army had. If the situation became more serious, then additional trucks could also be used for the same purpose.

There is no question but that in other theaters of war, when a war of maneuver has been carried on, these trucks have been used to carry troops on raids accompanying cavalry. The supply trains with cavalry have also been made up of the transport.

The animal-drawn army trains or grand parks, except certain vehicles of the artillery and engineers, have been entirely done away with and their work done by the army automobile convoy.

On the line of communication and in the zone of the interior practically all the transportation in general use is motor-drawn.

The escort wagon has somewhat the same drawbacks as an auto truck when it comes to moving off the roads and in the fields. During this war certain troops could not have held positions had they not a vehicle of resupply that was capable of getting off a road covered by hostile artillery fire and passing through fields under cover to near the troops. It is believed that we should give some serious study to the working out practically of this question of a suitable type of combat train wagon.

The heavy auto-truck companies are often supplied with trailers, the trailer having the same carrying capacity as the truck. This type usually carries 3 tons, but for all-round service a 1½-ton truck has been found most acceptable. The use of trailers, however, must depend upon road conditions, and where good road conditions do not exist the strain on the truck is so great as to render the use of the trailers with the truck not advisable.

The number of auto trucks is usually fixed by the number of vehicles required to transport either one day's rations for a corps (125 tons) or two "lots" of ammunition, infantry and artillery (160 tons). The trucks are expected to make 12 miles an hour and to be able to travel about 100 miles a day.

The personnel with an auto-truck company varies, but it is not far from the organization prescribed for our motor-truck companies. (See Tables of Organization.)

The use of motor transport has reduced, by many men, the personnel of the service of supply, thus releasing a greater number of men for the firing line. In the past, during some wars, the number of men required behind the lines was equal, if it did not exceed, the number of fighting men.

Automobile Parks

The extended use of automobiles of every type in the present war has created some new problems, one of the most important being the maintenance of the various motor wagons in a condition for service. Although the reliability of motor cars has been enormously improved in recent years, they, more than most machines, are subject to many ills and troubles.

Motor-car troubles may be conveniently grouped under three heads: Ordinary road troubles, such as can be repaired by chauffeurs or mechanicians with the simple tools and repair parts carried for this purpose; second, more serious troubles, which call for shopwork; third, very serious troubles, which call for factory work.

In order to meet satisfactorily the second class of troubles, those calling for shopwork, recourse is had to the organization of so-called automobile parks, one for each field army. Like many other features of the present war, the automobile park is a new creation called for by the emergency of the situation. The number of automobiles of all kinds assigned to the field armies varies according to the conditions, such as size and extent of front of the army, character of country as regards available roads and railroads, etc. The automobiles assigned to each army are numbered serially, and by observing the numbers noted at different times and places a fair idea of the number of machines belonging to a field army may be obtained. This number averages not less than 2500 per field army, including both passenger and freight autos. It is evident that with so large a number of machines constantly doing hard service there will be need for some organized and controlled scheme for repairs. This is the task of the automobile park.

In a populous region where position warfare has obtained for some time the problem is easy. Existing garages or machine shops in conveniently located towns afford all necessary requisites for an automobile park and permit of undertaking repairs on a large scale. On the other hand, where field warfare has been the rule and where large industrial towns and villages are lacking, the problem is more difficult, requiring, in the first place, that the repair park have a certain amount of mobility and also that it carry along its equipment and appliances. Under these conditions the repairs that can be undertaken in the field are more limited.

Supposing a field army to be established in some garrison camp, its personnel would be housed in the barracks of the peace garrison. If no suitable buildings were available for shops and garages, suitable light-frame structures are erected, arranging the buildings by centering the repair departments around the sides of a rectangle, with open sheds in the center for housing machines repaired and awaiting repairs.

The various shops are a carpenter shop, painting and glazing shop, machine shop equipped with power lathe, shaper, emery wheel, drill press, etc., a vulcanizing shop, a blacksmith shop, and an oxy-acetylene welding outfit. The latter is a most useful affair, enabling broken parts of steel, brass, and even aluminum to be welded together. There is also a small printing shop for printing various blank forms used by chauffeurs in recording car performances. A large stock room containing spare parts of all usual makes of automobiles forms part of the park and enables repairs to be made very quickly.

About 200 cars are usually on hand at the park, some pretty bad cases among them, including several which had suffered from shell fire. With appliances available quite serious repairs can be undertaken without returning cars to factory. A supply of repaired cars in running order is maintained from which issues can be made in exchange for cars turned in for repairs.

The personnel of the park consists of one captain, taken from the railway regiments; two lieutenants, one from the cavalry and one from the artillery; and about 400 men drawn from recruit depots, and most of them skilled workmen.

THE ARMORED CAR

The weak point in the comparatively heavy armored car lies in its dependence on the condition of the road and its helplessness before ordinary obstacles, such as ruts and ditches. It has its uses, however, under the conditions noted in the following remarks:

"In the German Invasion of Belgium * * * motor vehicles apparently played an enormously important part in enabling the enemy to push forward more rapidly than he could have done had he had to depend entirely on his cavalry. The armored car early proved its value for this sort of patrol work. It exercised another influence on the cavalry arm, in that, by expediting the rate at which it was possible for the invader to push forward, it placed correspondingly a greater strain on the mobility of cavalry, and to that extent used up the horses of the enemy at an additional rate, as instance the extremely ill condition into which they got last autumn.

"Thus in this connection the advent of the motor vehicle to modern warfare made possible operations beyond the scope of cavalry unaided, and at the same time put a greater strain on that arm. It has also speeded up the movement of the main armies, because, unlike horses, motor vehicles do not tire during the spells in which it is possible for men to work them."

MOTORCYCLES

These have generally proved unsatisfactory, and for messenger and orderly service they have been replaced by the light motor car. Light 4 or 5-horsepower, two-passenger cars, like the Bébé Peugeot and the Zebre, can go almost anywhere.

In some newspaper reports and in letters from the front rumors of the use of a large number of motorcycles to move troops occur, but no verification of this has ever been received through official channels.

Based on these reports an organization of a large number of motorcyclists has been proposed, with a view to their use in place of cavalry. Notwithstanding the comparative invisibility of the motorcycle and its individual adaptability to a varied terrain such a plan appears unfeasible. In the first place the men would have to be trained as soldiers before they can become military cyclists, and, in the second place, no teamwork of the mass could be assured without some training of the whole as a body.

Companies for duty at Army corps or division headquarters are feasible, but it is not believed that large bodies can operate with the same ease as cavalry. It is safe to assert that during operations in Courland a motorcycle corps of 60,000 could not have replaced that amount of cavalry or have done the work expected of them.

USE IN COUNTRIES HAVING FEW ROADS

Perhaps the phase which has most vividly brought home the change wrought by the advent of the motor in the conduct of military operations has been its employment during the campaign against De Wet.

The average mind can here appreciate the advance made by the present-day methods of warfare, as the scene was identical in nature with that of 15 years ago, when something in the neighborhood of a quarter of a million British soldiers were engaged in rounding up De Wet and his Boers. There is, however, this difference, that, while the numbers concerned were much smaller than in the campaign referred to above, the uprising led by De Wet was in the nature of a surprise, which made the mobilization of the necessary troops and the accumulation of supplies impossible in advance of the emergency. The hostile Boers in this instance had precisely the same mobility which enabled them to elude the British troops so easily 15 years ago.

The difference in the later campaign is shown by the fact that motors were employed instead of horses and horse-drawn transport.

"But these cars were not built for military use, being merely machines owned by members of the Johannesburg Automobile Club, many designed for use only on roads as we understand them in Europe. The work in hand, however, required that the cars should be driven across country in all manner of directions, over the veldt where there chanced to be neither road nor track, and across the beds of rivers.

"Moreover, the vehicles usually carried something more than the normal load. Scarcely two cars were of a kind or model. Thus, from the point of view of military service, it would have been impossible to select anything in the way of motor vehicles less suitable for the task. Of course, many of the cars broke down, as they are breaking down every day in the war area in Europe. But the thing that counted was that more cars got through than fell out of the running, while of those that failed it must be observed that up to the point at which it broke down each assisted to keep the enemy on the run. To that extent it did its work toward rounding him up."

AMBULANCES

Motor traction has worked wonders in this war with the food and ammunition supply, yet in each one of these services the final stage is still made by horse-drawn vehicles. However, under the existing conditions of trench warfare the sanitary service has gone even further and have supplanted all slow-moving horse-drawn vehicles by light and efficient motor ambulances.

"The motor ambulance is the machine for which the ordinary pleasure car chassis, unaltered, has proved most suitable. The provision of these ambulances has undoubtedly contributed enormously to the saving of life and suffering. But the best of them scarcely begins to realize the possibilities of a motor vehicle for this service in regions in which roads are either lacking or are torn up as a result of warfare. They are no longer using ambulances having the excessive overhang so common among those presented at the beginning of the war. But that is only a slight improvement, for even today the driver of the average motor ambulance sits in the best swung position. At least part of the patient's body as he lies flat—usually the feet and the lower part of the legs—projects behind the back axle.

"Nor should motor ambulances have too long wheel bases, because it is often necessary to turn them in brief compass. Obviously the driver should not be placed where he sits in an ordinary touring car or town carriage. If the motor must be accommodated in the same part of the chassis, then the ambulance driver and the attendant seated beside him should be placed above the engine, as they are in certain types of French and German motor buses.

"This arrangement would enable the best part of the chassis ordinarily occupied by the driver to be used by the patient, the whole of whose body could accordingly be brought well between the two axles. There is nothing to the speed at which these ambulances have to be driven that would render it undesirable to accommodate driver and attendant above the motor. Nor is this all, for the present system of springing is at best a mere combination of makeshifts, in that all springs are the result of building up laminations plates.

ach spring so built up can give the smoothest riding only at certain ons and certain loads, whereas the whole point of having a motor vehicle for any sort of service is that you can use it either with full load, with part load, or without any load; also that you can drive it over any sort of surface at any speed of which it is capable, from the slowest to the fastest. No form of laminated steel spring can therefore be quite suitable for the purpose. Possibly pneumatic suspension will prove a successful solution of the problem."

These motor ambulances, under cover of darkness, come right up to the dressing stations and evacuate direct to the clearing stations, which are back at corps headquarters in some suitable building. It is due altogether to these swiftly moving ambulances that wounded can be forwarded to the base and finally to England. A man if wounded in the forenoon is out of luck, but the man wounded in the afternoon may reach a hospital in England before his name reaches his corps headquarters as among the wounded.

FUEL

Sufficient data do not yet exist from which we can state definitely the various kinds of fuel employed. Among those mentioned are alcohol, benzol, kerosene, and gasoline. Shortage in gasoline and increase in the price will undoubtedly cause a search for a new fuel. Its arrival is certain, as there has never been a crying demand for any improvement without an answer from the engineers and inventors. Improved carburetors and lighter cars show, in a way, the line of advance of improvements.

With the export demand, the war, and the domestic demand, there does not seem to be much thought of lower prices for gasoline. While kerosene could be used and would be cheap, it has, up to this time, exhibited a tendency to give off an odor when burned and it also leaves an excess of carbon in the cylinders. The low grade of gasoline is a little more difficult to start on, but it supplies more heat and is a better fuel for general work after the motor is under way.

Some moderately successful attempts have been made in this respect, but, although the cost has been reduced to 7 cents per mile, a great deal of trouble exists because of the sediment left in the carbureter. This may, however, be remedied by study, and we may have a new less expensive fuel before long.

Thus the war has speeded up the development of the motor car, permanent improvements will result and, perhaps, a new fuel.

DEFECTS IN CONSTRUCTION BROUGHT OUT UNDER THE STRAIN OF ACTIVE-SERVICE CONDITIONS

Lack of standardization of parts and the continual breaking of radiators are mentioned as being the main troubles encountered in handling this kind of transport. The last trouble undoubtedly comes from the shock due to bad roads and to continued use without an opportunity for repairs or rest.

For the student who has studied carefully the development of this transport the most gratifying thing about remodeling the proposition of modern warfare, made possible by the arrival of the motor vehicle, is the fact that every accomplishment and every success, up to date, stands to the credit of machines neither specially designed nor produced for war purposes.

chassis by large owners who might after the war, in the interest of standardization, continue their purchases of trucks made outside of France.

"The foreign trucks now used by the French Army are run until they are useless and can not be overhauled advantageously, and are then replaced by French-made chassis, the latest advices from France being that the factories there are now in a position to care for the army's needs."

CONCLUSIONS

The question is at once asked whether or not we have taken steps to use this transport and to avail ourselves of the large amount of suitable material existing today in the United States.

The answer is made that this has been done as far as existing appropriations will allow. However, most of these vehicles are operating singly or in pairs, and at no one place are there sufficient for one company.

ORGANIZATION

The organization proposed for a motor-truck company conforms to the experience of officers abroad, but as yet no attempt has been made to collect the material of automobile parks or for repair shops and these are shown by the experience of all to be badly needed in field operations.

The assignment of this transport to the divisional trains is correct and conforms with the practice abroad.

There should be organized in each division a motor-truck company, and attached thereto a repair shop. This organization will form a cadre as well as a place where chauffeurs and mechanicians can be trained. It is true we can recruit plenty of men from this class when war is imminent, but it is one thing to be a chauffeur and another to be a military chauffeur.

Abroad this defect does not exist, but with us something should be done to remedy the lack of disciplined material. The experience of certain of the belligerents in this respect will be ours if we become involved in war.

COLLECTION OF THIS TRANSPORT

Based on the type of vehicle *in use* in the cadre in each division, attempt ought to be made to arrange for a large number of vehicles *of a similar type*. The same type of vehicle, as far as possible, should be used within a division or even a field army if such can be accomplished.

The Federal Trade Commission could under the law obtain the data, in each divisional district, necessary for listing suitable transport. The Quartermaster General's Office has prepared a provisional plan for utilizing motor transport, under existing laws, and this plan includes a contract system which will take the place of the prizes and subsidies that have been found so efficacious abroad.

All these steps are in the right direction, and we have conserved the underlying principle for the use of mechanical-driven transport, and this is that it is a transportation unit pure and simple. It picks up a load at one place and discharges this load upon arrival at destination. It is not employed in transporting mobile reserves. The animal-drawn vehicle transports the rolling reserve. Animal-drawn vehicles are still being purchased in great numbers by the French. A recent order has been placed for over 4000 of these wagons. The French have not as yet replaced the animal-drawn transport of combat and field trains with autotrucks, nor do they apparently intend to do so. The corps supply, ammunition, and sanitary trains remain animal-drawn, except that automobile ambulance sections form part of the sanitary train, and fresh-meat automobile sections form part of the supply train.

The foregoing facts are striking when we consider the excellent roads being maintained in the theater of operations. The animal-drawn vehicle will undoubtedly be eventually replaced by mechanical-driven transport. However, before this can be done, even in Europe, many mechanical imperfections at present existing in the autotruck must be overcome. Our problem in this particular is more difficult than the European, when we consider the roads and bridges in our probable theater of miliatry operations, and it is very possible that we will not be able to make the change until some time after it has been effected in Europe. Notwithstanding the fact that it may be some years before we can use autotrucks in our first and second lines of transportation, the fact remains that, in the event of a war, we will have need for this kind of transportation in great quantities behind our second-line transportation.

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THE GREAT NORTH SEA BATTLE[*]

German Official Story of the Skagerrak Sea Fight[†]

In the course of one of its customary maneuvers in the North Sea, made, like all previous operations of this character, with strategic designs, which on this occasion carried the fleet into the Skagerrak, our high seas fleet, under the command of Vice-Admiral Scheer, and consisting of three squadrons of battleships, five armored cruisers of the "Derfflinger" and the "Moltke" types, a large number of new and old small cruisers, and several torpedoboat flotillas, was on May 31 in action with the enemy.

At about 4:30 P. M., some 90 miles west of Haustholm, our vanguard of small cruisers comes unexpectedly upon eight small English cruisers of the "Calliope" class accompanied by 15 or 20 of the newest and largest destroyers of the N class. While our light forces, followed by the armored cruisers of the first scouting group under the command of Vice-Admiral Hipper, are concentrating upon the English, and while the latter are withdrawing toward the northeast, our armored cruisers sight, in a westerly direction, two columns of large ships forming in line toward the southeast. These are soon made out to be the first English battle-cruiser squadron under the command of Vice-Admiral Beatty, consisting of six of these vessels, four of the "Lion" and two of the "Indefatigable" class. Our armored cruisers are at once brought into running action with the enemy on a southeasterly course. With clear weather, a light wind from the northwest, and a calm sea, they are drawn into line and at 5:49 P. M., with a range of 13,000 yards, they open fire from their heavy guns upon the superior force of the enemy. After about 15 minutes of action our fire causes a tremendous explosion aboard the last battle-cruiser of the enemy line, the *Indefatigable*, destroying the ship. At about 6:20 the enemy's line, now consisting of only five battle-cruisers, is joined by a strong re-enforcing squadron from the west, consisting of five ships of the "Queen Elizabeth" class, mounting the new 38-centimeter guns. These vessels at once go into line with the battle-cruisers, and after a brief engagement with our scouting groups the entire squadron thus formed opens fire upon our armored cruisers, which are now opposed by the overwhelming force of ten large ships. To cut down this superiority as much as possible, at 6:20 our torpedoboats are thrown at the opposing line. A bitter fight at close quarters ensues between these and the small enemy cruisers and destroyers that oppose them, and in which our small cruiser *Regensburg* also joins. We lose here two torpedoboats, whose crews are rescued under the heaviest fire by their sister ships; while on the side of the enemy, two destroyers are sunk by our gunfire and two more, the *Nomad* and the *Nestor*, put out of action. Later, after our torpedoboats have rescued all survivers, these are destroyed by our main fleet. During the height of this engagement, at 6:30, our accurate fire causes a terrific explosion on the *Queen Mary*, tearing her bodily in two. When the cloud of smoke has cleared away, the place she had occupied is empty.

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[*] See "Tactics of the Engagement as Described by British Naval Officers," commencing on page 76 of the JOURNAL U. S. ARTILLERY for July-August, 1916.

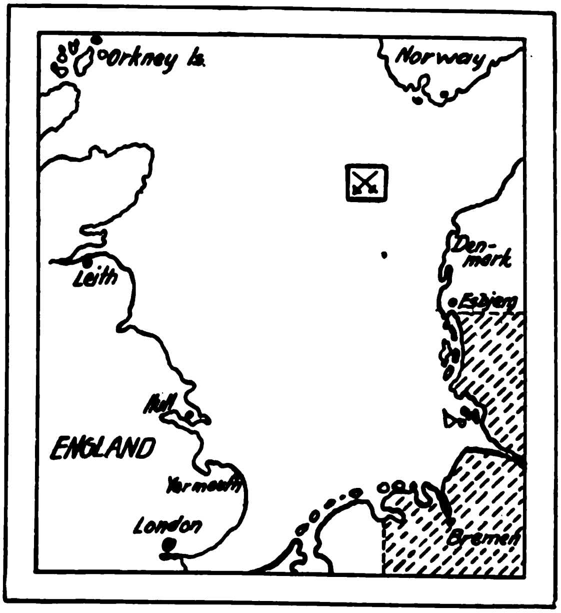
[†] Illustration of the four phases is on page 203.

Within a short time our main battleship fleet is seen approaching from the south. The enemy's small vessels at once turn to the north. With this, after an engagement of about an hour's duration, the first stage of the battle is brought to an end. The fast English small craft flee northward, with the German fleet in hot pursuit. Our armored cruisers continue to engage in a duel of rapidly increasing intensity with the "Queen Elizabeth" division particularly, while the battleship division at the head of the advancing line of our main fleet likewise exchanges intermittent shots with these. The enemy's mosquito fleet exhibits intentions of drawing itself into a wide arc before the head of our line. At 7:45 the small English cruisers and destroyers, which till that moment have stood close by the battle-cruiser squadron, break away from these; and while the battle-cruisers withdraw from the fight—permanently, so far as we have determined—the others make a rapid attack upon our armored cruisers, which by rapid maneuvering evade the torpedoes directed at them. Shortly thereafter our second scouting group, attempting to parry the attack of the destroyers, is the target for a heavy fire from the northeast, our small cruiser *Wiesbaden* being put out of action in short order. Portions of our torpedoboat flotillas, which at once launch an attack against the large ships appearing shadowlike through the wall of fog in the northeast, perceive on closer approach a long line of at least 25 battleships. These first seek a junction with their battle-cruisers and with the "Queen Elizabeth" division by taking a course between northwest and west; then they turn and steam in a southeasterly direction.

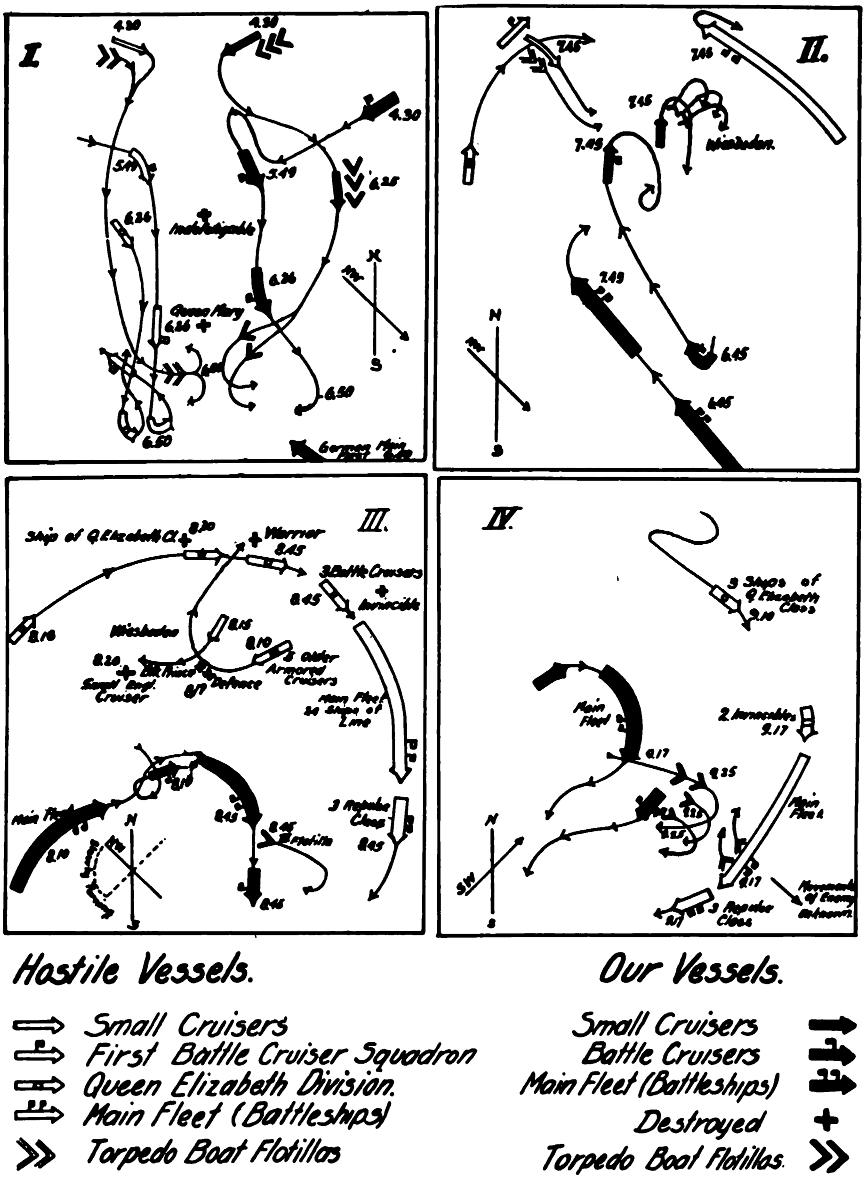
The appearance at about 8 P. M. of the enemy's main battleship fleet, whose nucleus comprise three squadrons of about eight battleships apiece, each attended on the northern wing by three ships of the "Invincible" type and on the southern by three of the entirely new "Royal Sovereign" class, armed with the 38-centimeter guns, marks the beginning of the third stage of the battle, bringing together the main fleets.

Vice-Admiral Scheer resolves to give battle to the English, although as is now known they are in full force and of more than double his strength.

Our battleship squadrons, with the armored cruisers at the head, make straight for the fogbank stretching across the northeast, from which such heavy fire has been directed upon the crippled *Wiesbaden*. Over a rapidly spreading area about this vessel there now spring up obstinate single combats. By reason of the increasing cloudiness, light enemy craft, supported by a squadron of five armored cruisers of the "Minotaur," "Achilles" and "Duke of Edinburgh" classes, which sallied in from the northeast as well as from the main hostile fleet, push forward in the direction of the *Wiesbaden* and are able to deliver concealed attacks upon our armored cruisers, and upon the leading division of our main line of battle. In this they are subjected to a galling fire, by which the small cruiser *Defence* and the armored cruiser *Black Prince* are sunk. The armored cruiser *Warrior* returns to her own line a wreck, to sink later. A small cruiser is severely used. Even before this two destroyers have fallen under the attack launched by our torpedoboats against the first battleships that hove in sight. A small cruiser and two destroyers suffer damage.



Our armored cruisers and the foremost of the battleship divisions of our main fleet are in this action and under the ever increasing fire of the enemy's battleship squadrons, which shortly after 8 o'clock swing noticeably out from the fog in a northeasterly, and later in an easterly, direction. At the height of the action, especially between 8:20 and 8:30, we note indications in the enemy line of the excellence of our gunnery. It is observed by several officers of our ships that a vessel of the "Queen Elizabeth" type vanishes into the air under circumstances very similar to those attending the disappearance of the *Queen Mary*. The battle-cruiser *Invincible* sinks, well hit below the water line. A ship of the "Iron Duke" class has been hit by a torpedo before this, one of the "Queen Elizabeth" class steams helplessly about in a circle, her steering gear apparently carried away. On our side the armored cruiser *Lützow*, after at least 15 severe hits, is unable to maintain its place in the line. Vice-Admiral Hipper therefore transfers his flag under heavy fire in a torpedoboat to the *Moltke*, the passing *Derfflinger*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4.30
4.30
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6.26
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German Main Fleet
II.
7.45
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III.
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Small Engl. Cruiser
Defence
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Main Fleet
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Hostile Vessels.
Small Cruisers
First Battle Cruiser Squadron
Queen Elizabeth Division
Main Fleet (Battleships)
Torpedo Boat Flotillas
Our Vessels.
Small Cruisers
Battle Cruisers
Main Fleet (Battleships)
Destroyed
Torpedo Boat Flotillas

1874

assuming direction of the fleet in the meantime. Part of our torpedoboats engage the main hostile fleet with good success. Here we lose a torpedoboat after repeated hits; and a hostile destroyer is seen sinking after being struck by a torpedo.

After this first heavy blow at the preponderant forces of the enemy, the contestants are lost to each other's sight in clouds of smoke and powder. But when the gunfire is checked for a space in consequence of this the commander of the fleet rallies all his available forces to another onset. Our armored cruisers, which with a few small cruisers and torpedoboats are again at the head of the line, shortly after nine o'clock strike back against a renewed heavy fire from the veil of fog, returning this handsomely with the aid of the foremost divisions of the main fleet. Running at top speed, the armored cruisers now hurl themselves with reckless valor into the task of bringing the torpedoboats within reach of the hostile line; and in the teeth of a raking fire they approach to within 600 meters. Several of our torpedo flotilla rush to the attack, deliver their blows, and in spite of the most violent opposition, turn back with loss of only one boat. After this second powerful stroke the battle wanes amid dense billows of smoke from guns and stacks alike. Following the next onslaught, several torpedoboats find, upon piercing the cloud of smoke, that the main enemy squadron is not there. Nor when the commander of the fleet sends our forces off on the southerly and south-westerly courses, upon which the foe was last seen, is there any trace of him.

Once more, just before 10:30, the battle lives again for a short time in the late twilight. Off to the southward our armored cruisers sight four hostile battleships, upon which they at once open fire. As two of our battleship squadrons join in, the enemy turns and disappears in the darkness. Our oldest small cruisers of the fourth scouting group are in a brief action against some old enemy armored cruisers, and with this the day of fighting is ended.

After the disappearance of the enemy, when our ships take up their night march to the southward, they are closely followed till dawn by hostile small vessels, whose lesson is made a light one by the general strategic plan and by the extreme darkness of the night. During a meeting between our fourth scouting group and a superior force of miscellaneous cruisers, which escape under heavy fire, the small cruiser *Frauenlob* is badly damaged, lost to sight, and seen no more. An armored cruiser of the "Cressy" class comes suddenly into view close to our battleship line, is afire under our cannonading within forty seconds, and after four minutes sinks. The destroyer *G 60*—the number is seen but indistinctly in the night, and is therefore not certain—the destroyers *G 3*, *78*, *G 06*, and *27* are sunk by our precautionary fire within a space of seconds. Another destroyer is rammed and cut in two by one of our battleships, and in addition seven destroyers, among them the *G 30*, are met and badly damaged. Others, among them the *Tipperary* and the *Turbulent*, which had been abandoned in sinking condition after the rescue of the surviving members of their crews, drift past our lines, some of them burning fiercely. Countless torpedo wakes are observed from our ships; but only the *Pommern* falls victim to an unquestionable torpedo blow. The small cruiser *Rostock* is hit, but remains float. The small cruiser *Elbing* is damaged by one of our battleships in n unavoidable collision in the course of a maneuver. After futile efforts keep her above the water she is at length allowed to sink after the crew has been transferred, to the last man. Finally, we lose a torpedoboat which runs upon a mine laid by the enemy.

The losses through the efforts of the enemy, which in sea fighting alone afford a measure of efficiency and inefficiency, are here summarized (the English losses are according to the most careful estimates):

	English	German
Battleships of the first line	1	0
Large armored cruisers	3	1
Older battleships	0	1
Small cruisers, etc.	3	3
Destroyers and torpedoboats	12	5

In addition the *Elbing*, through accident.

Of these the *Lützow* and the *Rostock* did not sink till after the battle.

It should be finally noted that aside from those here given, the German fleet has lost no ship of any sort, either during the battle or during the return to the base.

Against a strength ratio of 2:1, the ratio of losses was: large ships, 4:1; smaller ships, 2 or 3:1.—*Scientific American.*

THE NAVAL BATTLE OF THE SKAGERRAK

HOW THE ENGAGEMENT IS VIEWED IN GERMANY

By Captain Z. S. Hollweg, of the German Naval Department

One hundred and twenty-two years ago, on June 1, 1794, after a preliminary engagement of several days' duration, the British Lord Howe, with twenty-five ships of the line, decidedly defeated, four hundred miles off Ouessant, the French fleet of approximately the same strength, under Villaret. The English ships were superior to the French in the quality of their crews. Panic ruled in France. In the general butchery of the French Revolution the navy had lost its best officers; the superior generalship of the English admiral drove the untried seamanship of the French commander into battle against the latter's will, and by a reckless onslaught forced him to remain on the defensive to leeward of the British fleet. The loser left seven battleships in the hands of the victor, and others were sunk. Fatigue and the physical incapacities of the British admiral, almost seventy years old and exhausted by the mental strain of five days of continuous effort, hindered the chase and robbed the English of the evident profit to be derived from an unremitting pursuit of the vanquished foe. The best part of the beaten and demoralized French fleet reached a safe harbor, some in the tow of less severely damaged vessels.

Lord Howe attained his tactical victory, but was unable to reach his strategic goal; a strong French commercial fleet from America, which Villaret had been ordered, upon pain of death, to bring to a French port, ran safely into Brest under cover of his defeat.

In the history of English sea-power, the remembrance of this battle lives under the stirring name of "The Glorious First of June." More by reason of this appealing name than on account of its strategic and tactical significance the battle is almost as well known in England as Aboukir or Trafalgar.

On the 1st of June, 1916, the rosy tint of this day in English annals was somewhat dimmed. In the future, the recollection of the glorious day of 1794 will be mixed with the bitter taste of the 1st of June, 1916. Germany, too, now has her "Glorious First of June," when the German victory will be recorded in history under another name.

In spite of the reassurances, partly of official origin, which have appeared in it, in spite of a Churchill and a Reuter, the English press has not succeeded in converting the gloriously won victory of the German fleet into a defeat, into the "greatest success of the British sea-power since Trafalgar." Fortunately for the neutrals there are better sources of truth for open-minded writers than Reuter despatches or Churchill boasts. To the honor of the English press be it said that a considerable part of it is beginning gradually to abandon this falsification, and to speak in all earnestness of the Skagerrak sea fight as a "costly catastrophe for the English sea-power." Herr Hervé, who is a well-disposed critic of his Entente friends, has frankly espoused this interpretation. It is not to be denied that later, when an objective regard of all things is again possible even in France, a faint malignant joy will even here appear over this misfortune to the pretentious sea-power of her often brutal ally. In France the anniversary of the "Glorious First of June" is not in good standing. The remembrance of the loss of so many brave French seamen in this battle will remain alive in France through a certain famous picture in the Louvre. It represents an incident of the battle, the duel between the *Vengeur du Peuple* and the *Brunswick* an incident of true French bravery, to which Barrère devoted at the time an inspiring speech of commemoration.

TACTICS AND STRATEGY

A part of the English press has been at great pains for some time to represent the course of the Skagerrak fight about in these terms: The German fleet has had some secret strategic purpose. The British, on account of the unfortunate lack of light, were, from the first appearance of the Germans, not sufficiently well-informed to be able to attack in full force. The "over-bold" cruisers of the English fleet therefore met the greatly superior full force of the Germans. In combat with these vessels, which were also supported by submarines, mine fields, gas bombs, airships, and other "unfair" means, they suffered considerable loss. Then, when the genial British admiral at the proper moment brought up his main fleet, the German fleet unfortunately avoided the defeat and destruction prepared for it by flight to a safe harbor. Result: No attainment of the German strategic purpose, the complete tactical defeat of the German fleet by the superior English gunnery, no loss of prestige for England. The victorious English fleet rules the North Sea now as before.

The day will come when England herself will be ashamed of these fabrications. A correct historical study will be mercilessly freed from such self-delusions.

The official German report sets forth correctly the place, time of day, and course of the fight, and makes it clear what was planned and what was accomplished. No secret strategic purpose actuated the German fleet. It was anxious to fight and sought the enemy for that purpose where he had last been announced. For this very purpose the German fleet had previously gone to sea repeatedly. It is not its fault if the English fleet was not on the spot at an earlier date. Unlike the opponents of the English in the affair of 1794, its movements were restricted by no worries over the safety of a convoy, or any such matters. It always went to sea to fight. That the Germans desired to fight under the most favorable practical conditions possible, was their good right, especially in the rôle of the considably weaker party numerically. It was, and is, good tactics to be stronger at the point of contact than the enemy. Lord Nelson taught the world many years ago at Aboukir and Trafalgar that this applies to sea-power. Were it otherwise, the weaker party would never have a chance of victory. The outcome of the battle indicates that the German intention of fighting under advantageous tactical conditions was realized, thanks to skillful management by the German staff. Wind, weather, position of the sun, and location of the scene of action are all weighty factors in such a tactical calculation. The attacker, in this case the German fleet, had, as always, the advantage of determining the time and place of the battle, and of therefore being able to regulate to its own advantage many of the factors mentioned. That is always the advantage of the offensive over the defensive. To take the offensive is to command the enemy. He who does this has trust in his material and personnel. He reckons in advance upon victory and its fruits. To English dullness it seems incomprehensible that the German fleet, outnumbered almost two to one, did not come to anchor somewhere and wait patiently until the entire English force had gathered about unmolested in order then to be able to put through, without risk, the oft threatened programme of complete annihilation. This was not our intention. The German sea chief would not willingly help the English to such cheap renown.

The German fleet, so says the Naval Act of 1900, is conceived and built as a "risk-fleet." Contemplation of the risk of battle, it was hoped, would keep us in peace. When war became unavoidable, however, the risk of battle should be so great for the enemy that the position of even the strongest sea-power would be threatened thereby. The correctness of this underlying principle of our naval programme is now substantiated by the victory of the German fleet.

In war the deserving often make their own good fortune. The capable man is also lucky, for his plans work out as he intended. The German fleet made its own success on May 31. The happy sequel demonstrated the correctness of the plans and purposes.

The English assert that the battle was fought only between parts of the opposing fleets. This the official report has unequivocally contradicted. The entire English fleet was in action against the German. It was the constantly repeated attacks of our torpedoboat flotillas upon the head of the English battleship line, led by Admiral Jellico himself, that caused the English leader to break off the fight. An explanation for this can be sought and found only in the fact that the English battleship squadrons had suffered such heavy losses from our guns and torpedoes that a continuation of the maneuvers begun by him seemed dangerous to the English admiral. In any event, from this moment he withdrew from the zone of fire of our ships. Smoke and fog which gathered upon the field of battle unfortunately prevented this movement from being clearly discerned. From this point on, the German Commander-in-Chief executed all movements of our forces already begun without interference and as correctly as though on parade, and got the night march under way.

The absurd claim that submarines, Zeppelins, mine fields and poisonous gases were the sources of the German victory attained in honorable battle has been sufficiently refuted from German official sources. The English claim is very transparent. If neutrals must be informed that the sea-ruling and strongly preponderant English fleet has suffered such extraordinary and unlooked-for losses, the German victory must, at any cost, be denied to have had its origin in the natural way through "sheer hard fighting" of the warships with those queens of weapons, guns and torpedoes; some German deviltry must be exhibited as the source of the misfortune. English pride will not and cannot be satisfied that any other fleet has surpassed its own in gunnery. Popular opinion and the press in England have acted now as in the Anglo-American war of 1812-1814, when, against all expectations, several American frigates vanquished in single combat and destroyed vainglorious English opponents of equal size. Every trick of distortion was then employed in the effort to show that this outcome was due, not to the excellence of the American generalship and gunnery, but entirely to the superior armament of the American vessels.

Finally, the "flight" of the German fleet to its base. Which had the greater numbers—of battleships especially, but also cruisers and torpedo-boats—the English fleet or the German? Whose squadron had the greater average speed? Both fleets, as stated above, were in close battle contact almost until the fall of darkness. The German fleet was more than 150 miles from its nearest base, in the open sea. It is almost a straight line from the scene of the battle to Heligoland. Doubt as to the course of the German fleet could hardly exist. It was a short June night with barely five hours of darkness. Is there a single Englishman of intelligence who really hopes to make the world believe that an energetic, eager-to-fight, unhampered English admiral could not have kept in touch with the German fleet during the night by means of his light vessels, if the desire to wipe them out still lived in him, and the strength for this operation was at hand? Was physical and mental strength denied the comparatively young Admiral Jellico, as once before on June 1, 1794, it was denied the aged Lord Howe? Shall the ill success of the commander of the English fleet be taken as a confession of inadequate seamanship and deficient tactical skill on the part of his scout ships? In the hard drills of the long years of peace has not the English fleet, with its many swift cruisers, learned how to keep track through one short night of a hostile fleet numbering in the neighborhood of thirty capital ships? We do not believe it; we rate English ability too high for that. Sir Jellico has actually thanked Sir Beatty for his work of scouting. He must have been satisfied with it. Will the English commander have us believe that, on the basis of the information brought him by his observers, it was impossible for him, on the morning of June 1, to take a position which would have enabled him to offer decisive battle to the German fleet? The course of the latter was without doubt known to Admiral Jellico through the work of his scouts, either of those upon which the German fleet had had occasion to direct a precautionary fire, or else of those which successfully engaged the *Pommern* and the *Frauenlob*.

Like burning torches in the descending darkness, the wrecked English cruisers and destroyers marked out for him the path of the German fleet. Why did he not hurl at that fleet, whose destruction was his ordained task and his eagerly pursued purpose, the squadron of twelve vessels arriving fresh and intact from the south, thus holding the hostile forces until he himself could reach the new scene of battle? That he did not do this, that he did not even make an effort to do it, proves that he felt himself too weak for further battle. The victorious German fleet and the English admiral both steered for a home port, and the German ships found time on the way to rescue many brave English seamen of the sunken ships and to bring them in as prisoners.

The German commander and the whole German fleet actually waited on the morning of June 1, on their way toward the inner German waters, in the hope of finding the reinforced English fleet ready for further fighting. But they did not appear; when the sun of June 1 arose the sea was empty of the foe and remained so. For the German admiral to stay at sea with the purpose of seeking out the enemy there was no occasion. His end had been attained, his work finished. The desire to replenish his provisions and fuel, to give his brave crews their well-earned rest, and to disembark his wounded in order to be quickly ready for a new encounter, easily explains his decision.

WHAT THE NAVY THINKS

Long before the present murderous war broke out, and in spite of all effort at refutation from authoritative German sources, Englishmen have spread the fairy tale that at every banquet German naval officers drank "to the day"; that is, to the day on which the German power should be called upon to measure itself in conflict with English skill. It is not necessary to point out here that this whole invention had an inciting tendency of the worst sort. The German naval officer has always had the highest regard for the English comrades with whom, in foreign countries, he has often and gladly associated upon most friendly terms. We all know that we have learned much from the English navy, we know the glorious histories and traditions of English sea-power. We know that on the true "glorious 1st of June" namesakes of the *Invincible*, *Defence*, and *Marlborough*, which now on this June 1st our guns have laid low, fought in the victorious English line. We knew English history so very well that we were perhaps a bit inclined to over-value its lesson. With the history of the origin of the present-day British sea-power, built up upon the ruins of every commercial competitor—first Spain, then Holland and France—we were familiar. The envy and hate with which our maritime syndicates were met in England spurred us on to complete at the earliest possible moment the undertakings which were necessary to justify our confidence and put the defense of Kaiser and country in our hands, if it should come to pass that the appeal to arms must be made. We prepared ourselves in advance to do our duty should the Fatherland call. No more, no less. Bloodthirsty hatred or envy of England's fleet we have never cherished. That, in case of necessity, the navy would be eager to do its duty, every single man has solemnly and silently vowed. Drinking and toasting in this connection would have seemed to us the height of bad taste. When the war at length broke out, we were eager to show the worth of our fathers and to return our thanks for all the love and inspiration with which the German people in the past few decades had advanced the growth of its darling child, the fleet.

But now, when the hour of decision has at length struck, when excellent leadership and a favorable fortune have given the fleet opportunity to show that we also know how to fight, to conquer and to die, when material and men have met unfaltering the ultimate test, when England's strongest

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spoke right from the hearts of the officers and other members of vy, when he extended his thanks and the thanks of the German to the great armorer of the fleet, Admiral von Tirpitz, and to the guished instructor and exemplar of the officers, Admiral von Köster. eet always suspected what it owes to these two leaders, but after this f battle it knows; without their labors, without their sweeping con- tions, the great work of fleet-construction and fleet-formation would remained incomplete. But in this, its hour of glory, the fleet also has ks for others. All those who, in year-long tiresome labor, have given r best toward the creation of an efficient navy and a body of glorious litions are rewarded, by the victorious outcome of this battle, for their nt labors in time of peace so little observed by those outside the inner le.

In one sentiment, the minds of the entire navy are united, alike those the victors in the North Sea fight and those who were left at home; in ankful thoughts to those who, in distant foreign lands or upon the shores t the Fatherland, have given their lives for the sake of the flag, and whose ames adorn the tablets of honor in our churches. At every anniversary f the "Glorious First of June" the graves of these and of all those who on this day of battle in May, 1916, have died for Kaiser and country will, in grateful remembrance, be decorated with a cross of the bright spring foliage of the German oak.—From *Die Woche* in *Scientific American Sup.*

GERMAN ADMIRALTY'S ACCOUNT

Berlin, June 29 (via London, June 30).

The German Admiralty has given to The Associated Press a detailed account of the recent naval battle in the Skagerrak. The following abstract has been taken from the Admiralty statement:

"The High Seas fleet, consisting of three battleship squadrons, five battle-cruisers, and a large number of small cruisers, with several destroyer flotillas, was cruising in the Skagerrak on May 31 for the purpose, as on earlier occasions, of offering battle to the British fleet. The vanguard of small cruisers at 4:30 o'clock in the afternoon suddenly encountered, 90 miles west of Hanstholm (a cape on the northwest coast of Jutland), a group of eight of the newest cruisers of the "Calliope" class and 15 or 20 of the most modern destroyers.

"While the German light forces and the first cruiser squadron under Vice-Admiral Hipper were following the British, who were retiring northwestward, the German battle-cruisers sighted to the westward Vice-Admiral Beatty's battle-cruiser squadron of six ships, including four of the "Lion" type and two of the "Indefatigable" type. Beatty's squadron developed a battle line on a southeasterly course and Vice-Admiral Hipper formed his line ahead of the same general course and approached for a running fight. He opened fire at 5:49 o'clock in the afternoon with heavy artillery at a range of 13,000 meters against the superior enemy. The weather was clear and light, and the sea was light with a northwest wind.

"After about a quarter of an hour a violent explosion occurred on the last cruiser of the "Indefatigable" type. It was caused by a heavy shell, and destroyed the vessel.

"About 6:20 o'clock in the afternoon five warships of the "Queen

fleet, severely damaged, must abstain from further act
many is decorated for a day in honor of the fleet, at t
from the faces of all to whom its participation was gr
ful, victorious, sober pride. And a little reflected gl
remaining members of the navy, to whom it was not
conquer. We are not foolish enough to believe th
is destroyed, for we know the English tenacity, t
upon the sea; and we feel that we have not stri
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in the ability of our leaders, in our ships and
creased. Anyone who knows the state of n
he has seen the old Reservists in action to
who has heard the shouting "hurrah" an
rain of hostile fire, anyone who has lear
of all our units, must know what to e
It is not ships that fight, but men! W
preponderant enemy again gives us
and spirit of German sailors will r
British seamanship and bravery.

Upon the medal which gra
victory of the "Glorious First
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The German fleet insist
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[illegible] llen victims to the attack of German
[illegible] ish battleships and a small cruiser and
[illegible] he German battle-cruisers and leading
[illegible] ngagements come under increased fire of
[illegible] which, shortly after 8 o'clock, could be
[illegible] the northeastward and finally to the east.
[illegible] artillery combat and shelling of great in-
[illegible] good shooting between 8:20 and 8:30 o'clock
[illegible] on German ships observed that a battleship
[illegible] blew up under conditions similar to that of
[illegible] *vincible* sank after being hit severely. A ship
[illegible] had earlier received a torpedo hit, and one of the
[illegible] as running around in a circle, its steering apparatus
[illegible]

[illegible] by at least 15 heavy shells and was unable to
[illegible] ne. Vice-Admiral Hipper, therefore, transhipped to
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[illegible] temporarily. Parts of the German torpedo flotilla
[illegible] main fleet and heard detonations. In the action the
[illegible] pedoboat. An enemy destroyer was seen in a sinking
[illegible] een hit by a torpedo.

[illegible] rst violent onslaught into the mass of the superior enemy
[illegible] st sight of each other in the smoke by powder clouds. After
[illegible] in the artillery combat Vice-Admiral Scheer ordered a new
[illegible] the available forces.

[illegible] battle-cruisers, which with several light cruisers and torpedo-
[illegible] headed the line, encountered the enemy soon after 9 o'clock
[illegible] the heavy fire, which was answered by them from the mist, and
[illegible] he leading division of the main fleet. Armored cruisers now
[illegible] nselves in a reckless onset at extreme speed against the enemy
[illegible] rder to cover the attack of torpedoboats. They approached the
ne although covered with shot from 6000 meters distance. Several
torpedo flotillas dashed forward to attack, delivered torpedoes, and
ed despite the most severe counterfire with the loss of only one boat.
artillery fight was again interrupted, after this second violent onslaught,
the smoke from guns and funnels.

"Several torpedo flotillas, which were ordered to attack somewhat later, und, after penetrating the smoke cloud, that the enemy fleet was no nger before them; nor, when the fleet commander again brought the German squadrons upon the southerly and southwesterly course, where the enemy was last seen, could our opponents be found. Only once more—shortly before 10:30 o'clock—did the battle flare up. For a short time in the late twilight German battle-cruisers sighted four enemy capital ships to seaward and opened fire immediately. As the two German battleship squadrons attacked, the enemy turned and vanished in the darkness. Older German light cruisers of the fourth reconnaissance group also were engaged with the older enemy armored cruisers in a short fight. This ended the day battle.

"The German divisions, which, after losing sight of the enemy, began a night cruise in a southerly direction, were attacked until dawn by enemy light force in rapid succession. The attacks were favored by the general strategic situation and the particularly dark night.

"The cruiser *Frauenlob* was injured severely during the engagement of the fourth reconnaissance group with a superior cruiser force, and was lost from sight.

"One armored cruiser of the "Cressy" class suddenly appeared close to a German battleship and was shot into fire after 40 seconds, and sank in four minutes."—From *New York Times* in *Proceedings of the U. S. Naval Institute.*

ADMIRAL JELLICOE'S REPORT

"Be pleased to inform the Lords Commissioners of the Admiralty that the German High Sea fleet was brought to action on the 31st of May, 1916, to the westward of Jutland Bank, off the coast of Denmark."

In these words Vice-Admiral Sir John R. Jellicoe, commander-in-chief of the home fleets, opens his report to the Admiralty on the battle over which there has been so much discussion. Continuing, Admiral Jellicoe says:

"The ships of the Grand fleet, in pursuance of the general policy of periodical sweeps through the North Sea, had left their base on the previous day in accordance with instructions issued by me. In the early afternoon of Wednesday, 31st of May, the first and second battle-cruiser squadrons, the first, second, and third light-cruiser squadrons and destroyers from the first, ninth, tenth, and thirteenth flotillas, supported by the fifth battle squadron, were, in accordance with my directions, scouting to the southward of the battle fleet, which was accompanied by the third battle-cruiser squadron, the first and second cruiser squadrons, the fourth light-cruiser squadron, and the fourth, eleventh, and twelfth flotillas.

"The junction of the battle fleet with the scouting force after the enemy had been sighted was delayed owing to the southerly course steered by our advanced force during the first hour after commencing their action with the enemy battle-cruisers. This, of course, was unavoidable, as had our battle-cruisers not followed the enemy to the southward the main fleets would never have been in contact.

"The battle-cruiser fleet, gallantly led by Vice-Admiral Beatty, and admirably supported by the ships of the fifth battle squadron under Rear-Admiral Evan-Thomas, fought the action under, at times, disadvantageous conditions, especially in regard to light, in a manner that was in keeping with the best traditions of the service."

The report states that "the list of ships and commanding officers which took part in the action has been withheld from publication for the present in accordance with the usual practice."

Admiral Jellicoe estimates the German losses at two battleships of the dreadnought type, one of the "Deutschland" type, which was seen to sink; the battle-cruiser *Lützow*, admitted by the Germans; one battle-cruiser of the dreadnought type, "one battle-cruiser seen to be so severely damaged

was extremely doubtful"; five light cruisers, seen to sink—
ossibly a battleship; six destroyers, seen to sink; three des-
maged that it was doubtful if they would be able to reach
bmarine sunk. (In the foregoing Admiral Jellicoe enumerates
vessels as probably lost. The last British report placed the

In concluding, Admiral Jellicoe says:

nditions of low visibility under which the day action took place
proach of darkness enhanced the difficulty of giving an accurate
e damage inflicted or the names of the ships sunk by our forces.
a most careful examination of the evidence of all the officers who
o seeing enemy vessels actually sink, and personal interviews with
mber of these officers, I am of the opinion that the list shown in
sure gives the minimum numbers, though it is possible it is not
as regards the particular class of vessel, especially those which
nk during the night attack. In addition to the vessels sunk, it is
tionable that many other ships were very seriously damaged by
e and torpedo attack.

I deeply regret to report the loss of his Majesty's ships *Queen Mary,*
atigable, Invincible, Defence, Black Prince, Warrior, Tipperary,
nt, Fortune, Shark, Sparrow Hawk, Nestor, Nomad, and *Turbulent.*
more do I regret the resultant heavy loss of life. The death of such
ant and distinguished officers as Arbuthnot, Hood, Captain Sowerby,
ptain Prowse, Captain Cay, Captain Bonham, Captain Charles J. Wintour,
d Captain Stanley B. Ellis, and those who perished with them, is a serious
ss to the navy and to the country. They led officers and men who were
qually gallant, and whose death is mourned by their comrades in the
rand fleet. They fell doing their duty nobly—a death which they would
have been first to desire.

"The enemy fought with the gallantry that was expected of him. We particularly admired the conduct of those on board a disabled German light cruiser which passed down the British line shortly after deployment under a heavy fire, which was returned by the only gun left in action. The conduct of the officers and men was entirely beyond praise.

"On all sides it is reported that the glorious traditions of the past were most worthily upheld, whether in the heavy ships, cruisers, light cruisers or destroyers; the same admirable spirit prevailed. The officers and men were cool and determined, with a cheeriness that would have carried them through anything. The heroism of the wounded was the admiration of all. I cannot adequately express the pride with which the spirit of the fleet filled me.

"It must never be forgotten that the prelude to action is the work of the engine-room department. * * * * Several ships attained speeds that had never before been reached, thus showing very clearly their high state of steaming efficiency. Failures in material were conspicuous by their absence."

Of the medical officers Admiral Jellicoe says:

"Lacking in many cases all essentials for performing critical operations, with their staffs seriously depleted by casualties, they worked untiringly with the greatest success."

The hardest fighting fell to the battle-cruiser fleet, says Admiral Jellicoe, the units of which were less heavily armored than their opponents, and he expressed high appreciation of the handling of all the vessels and commends

Admirals Burney, Jerram, Sturdee, Evan-Thomas, Duff, and Leveson, and continues:

"Vice-Admiral Sir David Beatty once again showed his fine qualities of gallant leadership, firm determination, and correct strategic fighting. He appreciated situations at once on sighting the first enemy's lighter forces, then his battle-cruisers, finally his battleships. I can fully sympathize with his feelings when the evening mist and fading light robbed the fleet of that complete victory for which he had maneuvered, for which the vessels in company with him had striven so hard. The services rendered by him, not only on this but on two previous occasions, have been of the very greatest value."

Vice-Admiral Beatty's report to Admiral Jellicoe particularly mentions the work of the *Engadine*, Commander Robinson, which towed the *Warrior* 75 miles during the night of May 31, and continues:

"It is impossible to give a definite statement of the losses inflicted on the enemy. Visibility was for the most part low and fluctuating. Caution forbade me to close the range too much with my inferior force. A review of all the reports leads me to conclude that the enemy's losses were considerably greater than those we sustained in spite of their superiority, and included battleships, battle-cruisers, light-cruisers, and destroyers. This is eloquent testimony to the very high standard of gunnery and torpedo efficiency of his Majesty's ships. The control and drill remained undisturbed throughout in many cases, despite the heavy damage to material and personnel.

"Our superiority over the enemy in this respect was very marked, their efficiency becoming rapidly reduced under punishment, while ours was maintained throughout. As was to be expected, the behavior of the ships' companies under the terrible conditions of a modern sea battle was magnificent without exception. The strain on their morale was a severe test of discipline and training. The officers and men were imbued with one thought—a desire to defeat the enemy.

"The fortitude of the wounded was admirable. A boy of the first class, John Travers Cornwall, of the *Chester*, was mortally wounded early in the action. He, nevertheless, remained standing alone at a most exposed post quietly awaiting orders until the end of the action, with the gun's crew dead or wounded all around him. His age was under 16½ years. I regret that he has since died. I recommend his case for special recognition, in justice to his memory and as an acknowledgement of the high example set by him.

"In such a conflict as raged for five hours it was inevitable that we should suffer severe losses. It was necessary to maintain touch with greatly superior forces in fluctuating visibility, often very low. We lost the *Invincible*, the *Indefatigable* and *Queen Mary*, from which ships there were few survivors. The casualties in the other ships were heavy. I wish to express my deepest regret at the loss of so many gallant comrades, officers and men. They died gloriously."

Extracts from Vice-Admiral Beatty's report give the course of events before the battle fleet came on the scene of action. At 2:20 o'clock in the afternoon the *Galatia* reported the presence of enemy vessels. At 2:35 o'clock considerable smoke was sighted to the eastward. This made it clear that the enemy was to the northward and eastward, and that it would be impossible for him to round Horn Reef without being brought to action.

The course of the British ships consequently was altered to the eastward and subsequently north-eastward.

The enemy was sighted at 3:31 o'clock. His force consisted of five battle-cruisers. Vice Admiral-Beatty's first and third light-cruiser squadrons, without awaiting orders, spread eastward, forming a screen in advance of the battle-cruiser squadron under Admiral Evan-Thomas, consisting of four battleships of the "Queen Elizabeth" class. The light-cruisers engaged the enemy and the cruiser squadron came up at high speed, taking station ahead of the battle-cruisers. At 3:30 o'clock Vice-Admiral Beatty increased the speed to 25 knots and formed the line of battle, the second battle-cruiser squadron forming astern of the first, with two destroyer flotillas ahead.

Vice-Admiral Beatty then turned east-southeast slightly, converging on the enemy now at a range of 23,000 yards. The fifth battle-cruiser squadron was then bearing north-northwest 10,000 yards distant. The visibility was good. Continuing his report, Vice-Admiral Beatty said:

"The sun was behind us. The wind was southeast. Being between the enemy and his base, our situation was both tactically and strategically good.

"Both forces opened fire simultaneously at 3:48 at a range of 18,500 yards. The course was altered southward, the enemy steering parallel distant 18,000 to 14,500 yards. The fifth battle squadron opened fire at a range of 20,000 yards at 4:08. The enemy fire then seemed to slacken. Although the presence of destroyers caused inconvenience on account of smoke, they preserved the battleships from submarine attack.

"Two submarines being sighted, and a flotilla of ten destroyers being ordered to attack the enemy with torpedoes, they moved out at 4:15 o'clock simultaneously with the approach of German destroyers. The attack was carried out gallantly with great determination. Before arriving at a favorable position to fire torpedoes they intercepted an enemy force consisting of one light-cruiser and 15 destroyers. A fierce engagement at close quarters ensued and the enemy were forced to retire on their battleships, having two destroyers sunk and their torpedo attack frustrated. Our destroyers sustained no loss, but the attack on the enemy cruisers was rendered less effective.

"The *Nestor*, *Nomad*, and *Minotaur*, under Commander Edward Bingham, pressed the attack on the battle-cruisers and fired two torpedoes. Being subjected to a heavy fire at 3000 yards, the *Nomad* was badly hit and remained between the lines. The *Nestor* also was badly hit, but was afloat when last seen. The *Petard*, *Nerissa*, *Turbulent*, and *Termagant* also are praised.

"These destroyer attacks," continues Vice-Admiral Beatty, "were indicative of the spirit pervading the navy and worthy of its highest traditions."

From 4:15 to 4:43 o'clock the conflict between the battle-cruiser squadrons was fierce and the resolute British fire began to tell. The rapidity and accuracy of the Germans' fire depreciated considerably. The third German ship was seen to be afire. The German battle fleet was reported ahead and the destroyers were recalled.

Vice-Admiral Beatty altered his course to the northward to lead the Germans toward the British battle fleet. The second light-cruiser squadron closed to 13,000 yards of the German battle fleet and came under heavy but ineffective fire. The fifth battle squadron engaged the German battle-cruisers with all guns, and about 5 o'clock came under the fire of the leading ships of the German battle fleet.

The weather became unfavorable, Vice-Admiral Beatty's ships being silhouetted against a clear horizon to the Germans, whose ships were mostly obscured by mist.

Between 5 and 6 o'clock the action continued at 14,000 yards on a northerly course, the German ships receiving very severe punishment, one battle-cruiser quitting the line considerably damaged. At 5:35 o'clock the Germans were gradually hauling eastward and receiving severe punishment at the head of the line, probably acting on information from their light-cruisers which were engaged with the third battle-cruiser squadron or from Zeppelins which possibly were present.

At 5:56 o'clock the leading ships of the British battle fleet were sighted bearing north, distant five miles. Vice-Admiral Beatty thereon proceeded east at the greatest speed, bringing the range to 12,000 yards. Only three German battle-cruisers were then visible, followed by battleships of the "Koenig" type.

Vice-Admiral Jellicoe then takes up the story of the battle fleet. Informed that the Germans were sighted, the fleet proceeded at full speed on a southeast by south course during two hours before arriving on the scene of battle. The steaming qualities of the older ships were severely tested. When the battle fleet was meeting the battle-cruisers and the fifth battle squadron great care was necessary to insure that the British ships were not mistaken for the German warships.

Vice-Admiral Beatty reported the position of the German battle fleet at 6:15 o'clock. Vice-Admiral Jellicoe then formed the line of battle, Vice-Admiral Beatty meantime having formed the battle-cruisers ahead of the battle fleet, and the fleets became engaged. During the deployment the *Defence* and *Warrior* were seen passing between the British and German fleets under heavy fire. The *Defence* disappeared and the *Warrior* passed to the rear, disabled.

Vice-Admiral Jellicoe considers it probable that Sir Robert K. Arbuthnot, the Rear-Admiral who was lost on board the *Defence*, was not aware, during the engagement with the German light-cruisers, of the approach of their heavy ships owing to the mist, until he found himself in close proximity to the main German fleet. Before he could withdraw, his ships were caught under a heavy fire and disabled. When the *Black Prince* of the same squadron was sunk was not known, but a wireless signal was received from her between 8 and 9 o'clock.

Owing principally to the mist, it was possible to see only a few ships at a time. Toward the close of the battle only four or five were visible and never more than eight to twelve.

The third battle-cruiser squadron, under Rear-Admiral Horace Alexander Hood, was in advance of the battle fleet and ordered to reinforce Vice-Admiral Beatty. While enroute the *Chester*, Captain Lawson, engaged three or four German light-cruisers for 20 minutes. Despite many casualties, her steaming qualities were unimpaired.

Describing the work of the third squadron, Vice-Admiral Beatty said Admiral Hood brought it into action ahead of the *Lion* "in the most ng manner, worthy of his great naval ancestors." Rear-Admiral at 6:25 P. M., was only 8000 yards from the leading German ship, and the British vessels poured a hot fire into her and caused her to turn away. Vice-Admiral Beatty, continuing, reports:

"By 6:50 o'clock the battle-cruisers were clear of our leading battle squadron and I ordered the third battle-cruiser squadron to prolong the line astern and reduced the speed to 18 knots. The visibility at this time was very indifferent, not more than four miles, and the enemy ships were temporarily lost sight of after 6 P. M. Although the visibility became reduced, it undoubtedly was more favorable to us than to the enemy. At intervals their ships showed up clearly, enabling us to punish them very severely and to establish a definite superiority over them. It was clear that the enemy suffered considerable damage, battle-cruisers and battleships alike. The head of their line was crumpled up, leaving their battleships as a target for the majority of our battle-cruisers. Before leaving, the fifth battle squadron also was engaging battleships.

"The report of Rear-Admiral Evan-Thomas shows excellent results were obtained. It can safely be said that his magnificent squadron wrought great execution."

The action between the battle fleets lasted, intermittently, from 6:17 to 8:20 o'clock at ranges between 9000 and 12,000 yards. The Germans constantly turned away and opened the range under the cover of destroyer attacks and smoke screens as the effect of the British fire was felt, and alterations of the course from southeast by east to west in an endeavor to close up brought the British battle fleet, which commenced action in an advantageous position on the German's bow; to a quarterly bearing from the German battle line, but placed Vice-Admiral Jellicoe between the Germans and their bases.

Vice-Admiral Jellicoe says: "During the somewhat brief periods that the ships of the High Sea fleet were visible through the mist, a heavy and effective fire kept up by the battleships and battle-cruisers of the Grand fleet caused me much satisfaction. The enemy vessels were seen to be constantly hit, some being observed to haul out of the line. At least one sank. The enemy's return fire at this period was not effective and the damage caused to our ships was insignificant."

Vice-Admiral Beatty's report covering this period says the German ships he was engaging showed signs of punishment. The visibility improved at sunset at 7:17, when he re-engaged, and destroyers at the head of the German line emitted volumes of gray smoke, covering their capital ships as with a pall, under cover of which they turned away and disappeared. At 7:45, the light-cruiser squadrons, sweeping westward, located two German battleships and cruisers. At 8:20, Vice-Admiral Beatty heavily engaged them at 10,000 yards. The leading ship, being repeatedly hit by the *Lion*, turned away in flames with a heavy list. The *Princess Royal* set fire to a three-funneled battleship. The *New Zealand* and *Indomitable* reported that the ship they engaged left the line heeling over and afire. At 8:40, the battle-cruisers felt a heavy shock as if struck by a mine or torpedo. This was assumed to be a vessel blowing up.

Vice-Admiral Beatty reported that he did not consider it desirable or proper to engage the German battle fleet during the dark hours, as the strategical position made it appear certain he could locate them at daylight under most favorable circumstances.

Vice-Admiral Jellicoe reports that, as anticipated, the Germans appeared to have relied much upon torpedo attacks which were favored by low visi-

"Seen in its broadest aspect, the battle stands out as a case of a tactical division of the fleet, which had the effect of bringing an unwilling enemy to battle. Such a method of forcing an action was obviously drastic and necessarily attended with a certain measure of risk.

"In the present case there was only an appearance of division. The battle fleet was to the north and the battle-cruiser fleet to the south, but they formed, in fact, one fleet, under a single command, and were acting in combination with one another. They were at the time actually engaged in carrying on, as they had been in the habit of doing periodically, a combined sweep of the North Sea, and Admiral Beatty's fleet was, in effect, the observation or advance squadron."

Admiral Sir Cyprian Bridge has prepared the following commentary on Admiral Jellicoe's report:

"To put the situation succinctly, it may be said that before the battle the British fleet at sea was divided into two parts, one force under Sir David Beatty and the other, the battle fleet or main body, under the commander in chief, Sir John Jellicoe. This distribution of the ships was the dominating factor in bringing on the battle. Had the whole British fleet been massed and close together it is more than likely that no battle would have occurred at all. So with the British fleet divided the Germans were encouraged to give battle with Beatty. Sir David, determined to get them into a fight, arranged the management of the action so that he could draw them nearer and nearer to Jellicoe's main body which was coming up in support. He thus greatly shortened the interval between the first collision and eventual participation in the action by Jellicoe's battleships.—From *New York Times* in *Proceedings of the U. S. Naval Institute.*

ESTIMATE OF FORCES ENGAGED

BERLIN, June 8, by wireless to Sayville, N. Y.

At the high tide of battle during the North Sea action of last week the strength of the British and German fleets engaged as given today from an authoritative German source was:

"British—At least 25 dreadnoughts, six battle-cruisers and at least four armored-cruisers.

"German—16 dreadnoughts, five battle-cruisers, six older German battleships and no armored-cruisers."

In addition, numerous light warships were engaged.—From *Washington Star* in *Proceedings of the U. S. Naval Institute.*

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THE NEW SHIPS

President Wilson, at 10:30 o'clock, August 29, signed the naval appropriation bill, which, among many new provisions relating both to personnel and material, carries the authorization for the great three-year building rogram, which includes ten battleships, six battle-cruisers, ten scout-cruisers, fty destroyers, nine fleet submarines, fifty-eight coast submarines, three el ships, one repair ship, one transport, one hospital ship, two destroyer enders, one submarine tender, two ammunition ships, and two gunboats.

The bill provides that the following vessels of the total number authorized shall be laid down as soon as practicable: Four battleships, four scout cruisers, four battle cruisers, twenty destroyers, thirty coast submarines, one fuel ship, one hospital ship, one ammunition ship, and one gunboat. The bill further directs that these vessels shall be contracted for, or shall be begun in navy yards, within six months from date of approval of this act.

During the last nine months the technical bureaus of the Navy Department have been working on the designs of the vessels which are to be laid down at once. In these designs they have incorporated military characteristics previously approved by the Secretary of the Navy, which are, for each type, the result of a careful study of the lessons to be learned from the naval operations in the European war, and the application of these lessons to the peculiar strategical requirements of the United States Navy. In the urgent deficiency bill, approved last February, Congress authorized the employment of a large number of additional technical employees in the bureaus of construction and repair and steam engineering, in order to expedite the preparation of these designs. As a result of this co-operation by Congress, and of hard and concentrated effort on the part of all its employees, the department has been able, on the very day of the approval of the appropriation bill, to advertise for bids for the construction of the four battleships, four scout cruisers, twenty destroyers, and thirty submarines of two distinct types. It has, also on the same day, directed the commandants, navy yards Philadelphia, Boston, and Charleston, to proceed with the construction of the hospital ship, the fuel ship, and the gunboat, respectively.

The battleships will be known for the present as battleships Nos. 45 to 48, inclusive. They will be slightly larger than their predecessors, the Tennessee and California. Their chief characteristics are: Displacement, 32,600 tons; speed, 21 knots; battery, eight 16-inch guns, eighteen 5-inch guns, four 3-inch anti-aircraft guns; complement, 1022. They will have the same very large cruising radius which characterizes all recent United States battleships. Their armor protection and underwater protection against torpedo attack will be unusually complete, and will include features which the experience in the war have shown to be of the most vital importance.

The scout cruisers, which for the present will be known as Nos. 4 to 7, inclusive, will be the largest and fastest vessels of this class ever laid down for any navy. The chief characteristics are: Displacement, 7100 tons; speed, 35 knots; length, 550 feet; beam, 55 feet; armament, eight 6-inch guns, four torpedo tubes, and two 3-inch anti-aircraft guns; complement, 330. Their high-powered machinery installations will be protected by light but efficient vertical and horizontal armor. A new feature of these vessels, never before incorporated in any ship of a powerful military type, will be their complete equipment for carrying, launching, and operating four of the largest size hydro-aeröplanes.

The torpedoboat destroyers, until assigned names, will be known as destroyers Nos. 75 to 94, inclusive. Following their predecessors, these vessels will carry a very heavy battery, and will have an unusually large cruising radius for vessels of their class. They represent a small increase in displacement over the last class laid down, but will deliver an increased speed of about 5 knots. Their chief characteristics will be: Displacement, 1185 tons; speed, 35 knots; battery, four 4-inch guns, four triple torpedo tubes, two anti-aircraft guns; complement, 95. It should be noted that these vessels will attain their rated speed on their full designed displacement, and not a very much lesser displacement, which can only be attained by stripping the vessels of many essentials, as is the case in a number of foreign boats of this class, for which very high speeds are claimed.

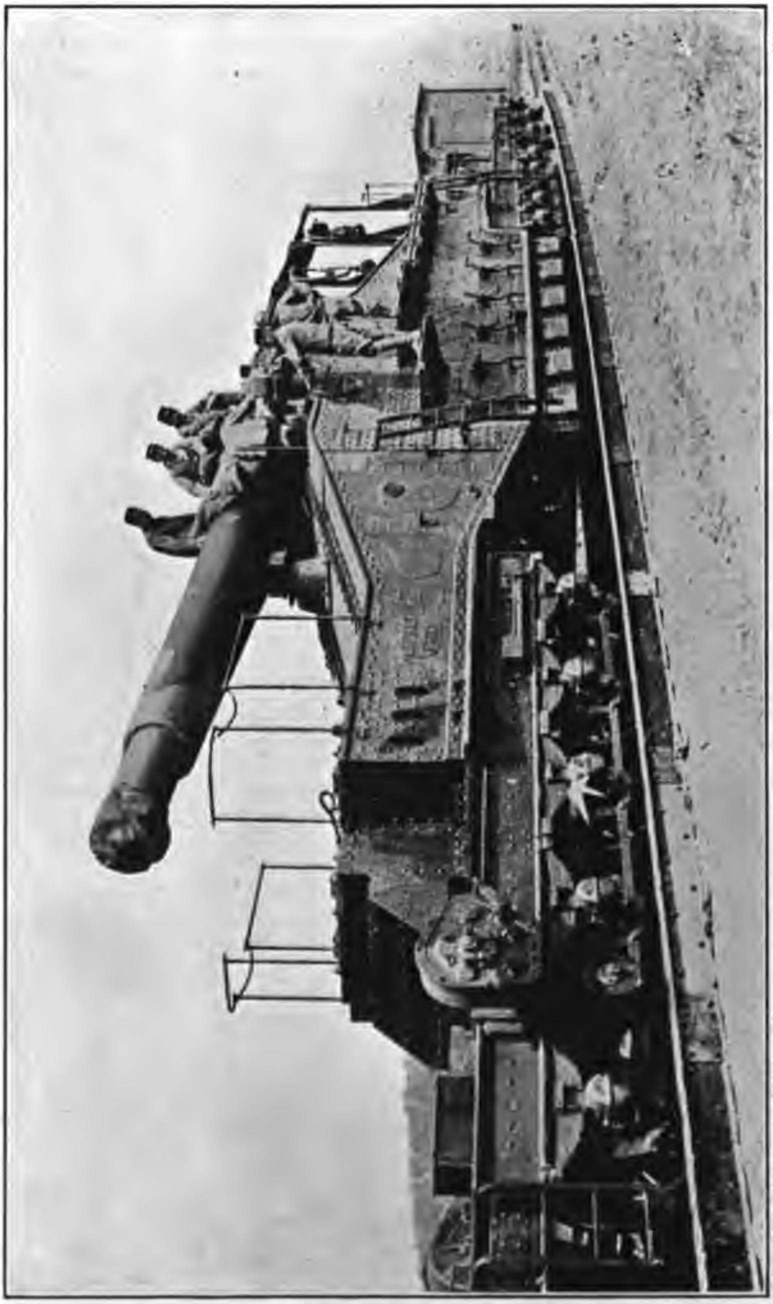
Of the coast defense submarines 27 will be of the usual type which have been built in this country for this purpose, but will include several new features tending to greatly improve their military value. These will be known for the present as Nos. 78 to 104, inclusive. The remaining three submarines, Nos. 105, 106, and 107, will be of a new type representing a marked increase in size over the usual coast defense submarine, and a decrease in size from the very large fleet submarine. Each of these three vessels will represent different ideas in their detailed designs, and it is hoped in their development to arrive at a size of vessel which will be sufficiently large to perform nearly all the duties required of a submarine, but at the same time will be sufficiently small to enable it to be built quickly in large numbers.

The hospital ship will be the first vessel built specially for this purpose for the United States navy. The ones now in use for this purpose are converted merchant vessels. The design has been worked out by the technical bureaus of the department in constant consultation with the bureau of medicine and surgery, with the result that it will embody every feature of the most up-to-date hospital on shore. It will have accommodations for 500 patients. Its chief characteristics and dimensions are: Displacement, 9800 tons; length, 460 feet; breadth, 60 feet 10¼ inches; draft, 19 feet 6 inches; speed, 16 knots. As this vessel will be immune from capture or attack in time of war, under the terms of the Geneva convention, it will not, in accordance with the terms of that convention, carry an armament of any kind for offense or defense, and in its design there are included no military features of any sort.

The fuel ship, which will be known for the present as fuel ship No. 16, will be a large oil tanker of ordinary commercial type, except that in many features its design will meet the requirements for a vessel which must accompany the battle fleet and be prepared to supply fuel oil to vessels of all sizes under adverse conditions of wind and sea. Its chief dimensions and characteristics are: Displacement, 14,500 tons; length, 455 feet; beam, 56 feet; draft, 26 feet 4 inches (about); total dead weight carrying capacity, 9600 tons; speed, 14 knots.

The gunboat, which will be known for the present as gunboat No. 21, will be a type of vessel designed especially for long continued service in the tropical waters. Its chief characteristics will be: Displacement, 1575 tons; length, 241 feet 2 inches; breadth, 41 feet 2½ inches; draft, 11 feet 4 inches; armament, three 4-inch guns, two 1-pounder guns, four 30 caliber machine guns, two 3-inch field guns, two 3-pounder guns; speed, 12 knots; complement, 149.

The only designs of the current program not yet completed are those for the battle cruiser and the ammunition ship. Plans and specifications for the battle cruiser will be completed and issued to bidders about October 1, 1916, and for the ammunition ship about November 1, 1916. This will permit contracts to be placed for these vessels by the end of the year, which will be two months in advance of the termination of the six months' period named in the appropriation bill.—*Army and Navy Register.*



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ONE OF A NUMBER OF LARGE CALIBER GUNS USED BY THE FRENCH ON THE SOMME FRONT

1878

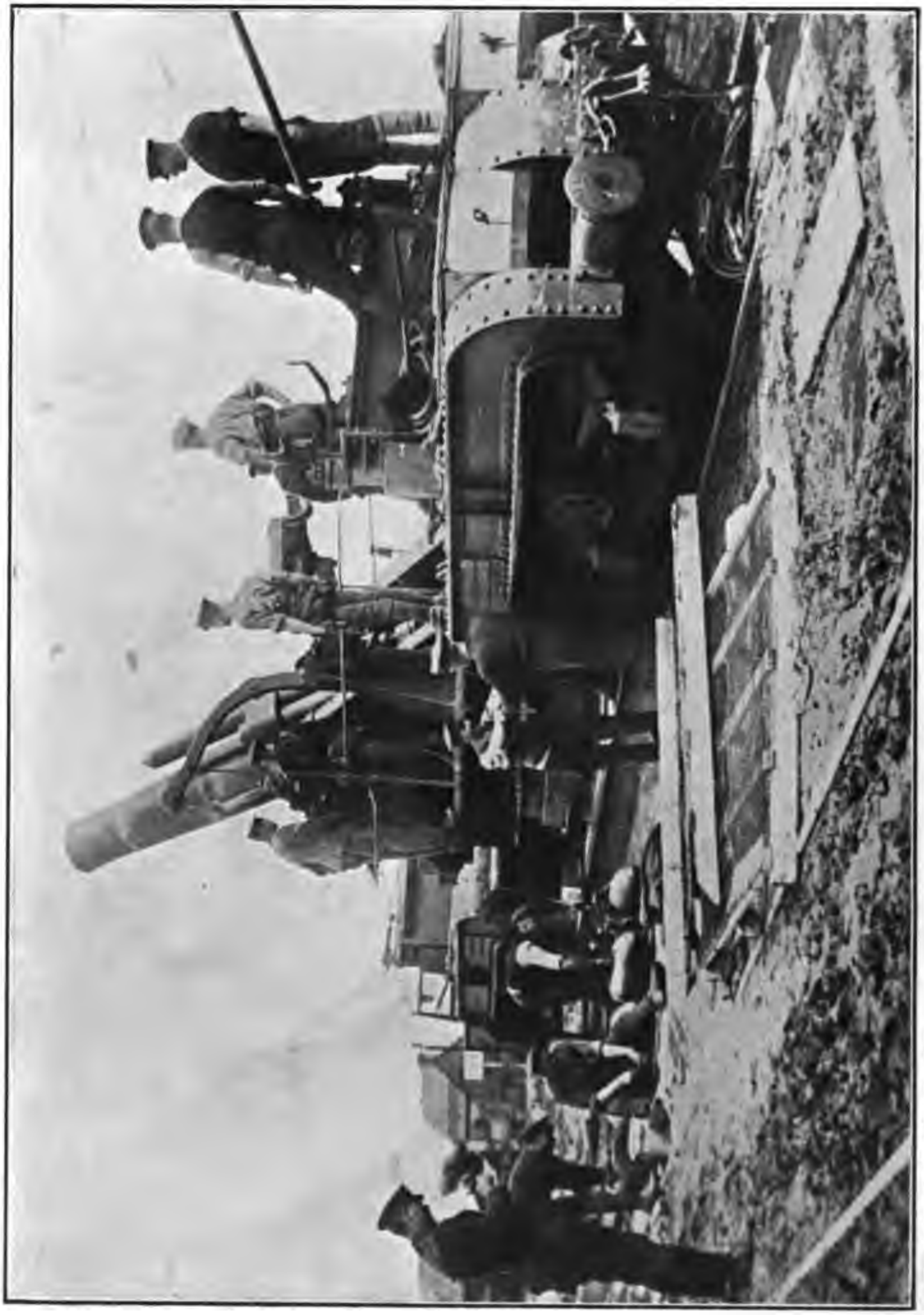


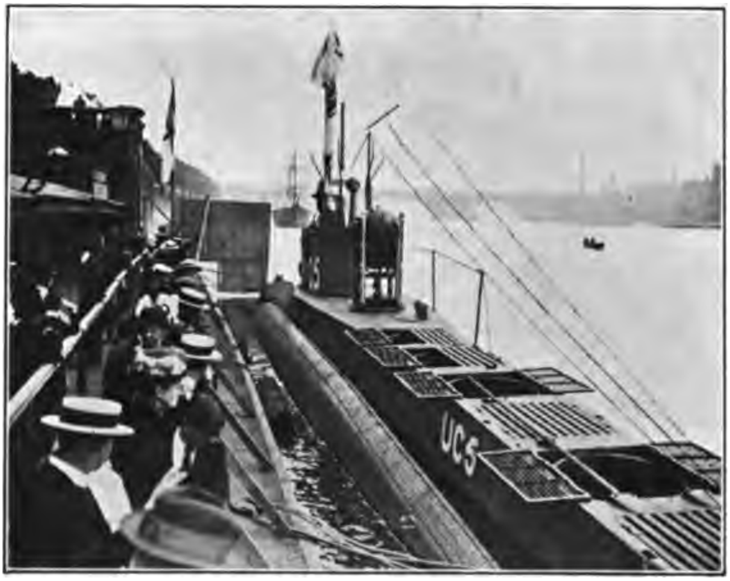
Photo by Boston Photo News Company.

1876

A Heavy British Naval Gun Mounted on a Railway Carriage from which It is Fired. To the Carriage are Attached Strong "Wings" which Take up the Shock of Recoil when the Piece is Fired

THE GERMAN SUBMARINE MINE-LAYER *U C 5*

The *U C 5* was found in distress somewhere off the East Coast by a British destroyer whose commander, through a megaphone, summoned the German to surrender. The submarine's crew held up their hands and presently jumped into the sea. As the destroyer's boat, after picking them up and taking them to the destroyer, was returning to the submarine, another man was seen to jump off her into the sea, and simultaneously several violent explosions took place on board her. The sub-lieutenant in charge of the boat put on a gas-mask and descended through the conning-tower hatch. He found that the submarine had been badly holed and had two feet of water in her. All her twelve mines were on board, but two had been dislodged by the explosions and were bumping about loose, liable to explode at any moment. An officer—since awarded the D.S.O.—bravely went down in diving dress and secured them, after two days' work, but could not remove the detonating-horns, so that the work of salvage was still perilous. Eventually the submarine was brought safely into harbor and docked. * * *

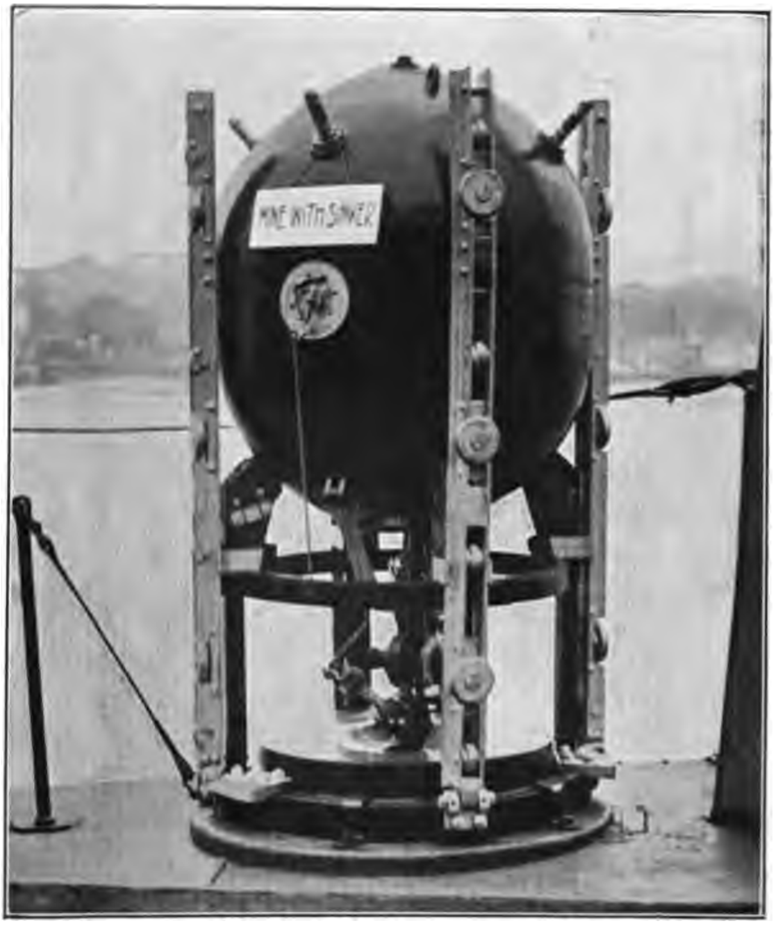


Copyright by Boston Photo News Company. 1877

German Submarine Mine-Layer "U C 5" Showing the Compartments for her Mines (See frontispiece.)

Mr. A. H. Pollen, the well-known naval expert, writes after visiting the captured *U. C. 5:*

"From the center forward it is pierced by six great wells, big slanting tubes, canted at an angle of about 70 degrees from the keel, and sloping downwards from the bows towards the stern. In each of these wells are housed two mines, one above the other—* * * with four * * * horns sticking out near the top * * *. The diameter of the weight [below the mine] is 6 inches or so greater than the diameter of the mine, and there are hinged to this weight four light galvanized-iron arms, which, when folded upright, lie flat against the mine, so that the * * * * [mine] seems to be sitting in a kind of cage * * *. Mine, weight, galvanized arms, and all * * * can be released from the tube by a catch control in the conning-tower, and then the whole device tumbles out and slips quietly to the bottom. Once it strikes bottom, contact with the water releases the holding mechanism that keeps the iron arms upright against the mine * * *. The mine * * * is buoyant, so that when the hydrostatic valve releases the cable that is coiled away in the weight, the mine rises slowly from its seat towards the surface. The valve is so constructed as to let out only so much cable as will allow the mine to reach a certain distance from the surface."



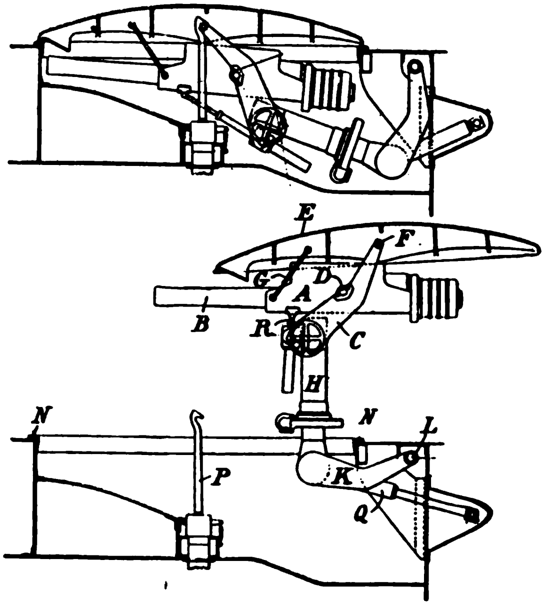
Copyright by Boston Photo News Company. 1878

ONE OF THE MINES CARRIED BY THE GERMAN SUBMARINE MINE-LAYER "U C 5"

—Extract from *The Illustrated London News.*

GUN MOUNTING FOR SUBMARINES

British Patent No. 40. January 1st, 1915. Sir W. G. Armstrong, Whitworth and Co., Limited, C. H. Murray and J. Richardson, Elswick Works, Newcastle-on-Tyne.



1879

The cradle A carrying the gun B is trunnioned on a carriage C as at D. A hood E is also trunnioned to this carriage as at F, the hood and the gun cradle being connected by links G. The carriage C can turn on a pivot H, which is supported by arms K hinged to the side of the submarine at L. The hood when lowered fits at its edge into a groove N. It is held in this position by a hook P, which grips on to the trunnion F. Q is a ram for raising the arms K. R is a ram for raising the gun and its cradle.

—*The Engineer.*

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A NEW BATTLESHIP DESIGNED BY ITALY

A new type of "unsinkable battleship" is described by Mario Monticelli, major of naval engineers of Italy, in the February issue of the *Rivista Marittima* (Maritime Review) of Rome. Major Monticelli has used, as the basis for the plan of his proposed new type of battleship, the armored cruiser *San Giorgio*, of the Italian navy. He points out the fact that of the many warships that have been torpedoed by submarines not a few of them have remained afloat and have reached port. This has suggested to the Italian engineer the idea of creating a type of ship especially built to resist the torpedoes' blows not only by additional armor protection, but also by a form of construction that would save the vessel from sinking in case of a stroke.

level temperatures, interesting as these may be. It is the prospect of a wider knowledge of the aerial ocean which lures the meteorologist. Until this work be accomplished, a man looking up at the clouds and with a map giving only surface conditions, can know no more about the sea of air above him than primitive man knew of the sea of water when he first ventured upon it. Small wonder that meteorology has made such slow progress in forty years; no wonder that weather maps seemingly alike should be followed by different conditions.

The term *aerography* is new, making its initial appearance perhaps with this article. Its meaning remains to be given; and at present we can hardly hope to do this so fully and completely that later modification will not be necessary. Like its analogues *geography* and *hydrography*, aerography, taken literally, means a description of the air. In the past four or five years the term aerology has been used in connection with the exploration of the upper or so-called free air; but it would seem more appropriate to let this term embrace the whole domain of atmospherics, while the word aerography might well be restricted to a description of the atmosphere at various levels. The flow and counter-flow of the air, the pressures, temperatures, humidities, dust content, electrical charge, etc., would thus be proper subjects for consideration under aerography, as well as their functions and relation to life; but such broader questions as the evolution of the atmosphere, its relation to the planet and to planetary phenomena, would be appropriately discussed under aerology.

Through the initiative of two non-official aerographers, the late Teisserenc de Bort and the late A. Lawrence Rotch, it has recently been established that the atmosphere is not of a homogeneous and uniform character but consists of two great divisions, a lower region, where temperature falls with elevation, and an upper region (in general higher than nine kilometers), where the temperature increases with elevation. The latter has been called the isothermal region, but such a name is rather misleading and should be discontinued in favor of Teisserenc de Bort's term *stratosphere*. The lower portion may appropriately be called the *troposphere*.

Pioneer but none the less excellent aerographies are "Charts of the Atmosphere for Aeronauts and Aviators," by A. Lawrence Rotch and Andrew H. Palmer, published in 1911,[*] and the "Structure of the Atmosphere in Clear Weather," by C. J. P. Cave, 1912[†]. The introduction to the first named volume is so brief and tells its story in such a straightforward way that we may well quote it entirely. Professor Rotch says:

"Although the exploration of the air, which was begun twenty years ago in France and Germany and at Blue Hill, was undertaken for the elucidation of meteorological problems, yet much of the data obtained is of importance for the new art of aerial navigation. Accordingly, some of the information which has been gathered by the Blue Hill Observatory in the United States and on the Atlantic Ocean through co-operation with a similar French institution, is here presented in a practical form for aeronauts and aviators. The term aeronaut is used to designate the pilot of a balloon, while aviator is restricted to the pilot of a flying-machine heavier than air.

"Thus the work which Lieutenant Maury did fifty years ago for the surface winds and ocean currents is now extended into the overlying ocean of air. This is the more necessary, since the whole aerial ocean is subject to stronger commotions than even the surface of the aqueous ocean and is navigable throughout a depth equal to that of the latter.

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[*] 24 full-page charts, with descriptions. John Wiley and Sons, New York, 1911. (Review in *Bull. Amer. Geogr. Soc.*, vol. xliv, 1912, pp. 861-862.)

[†] XII and 144 pp. University Press, Cambridge, 1912. (Review in *Bull. Amer. Geogr. Soc.*, vol. xlv., 1913, p. 62.)

"The following charts, which are believed to be the first of the kind adapted to the use of airmen, relate only to portions of the United States and the Atlantic Ocean, but they will doubtless be perfected by aerologists and extended in the near future to other parts of the globe."

Cave's book is essentially an investigation of the wind currents in the light of the results obtained by sounding-balloon work in Great Britain. Certain structural types are recognized and considered in their relation to the surface wind, the gradient wind, and the general pressure and temperature distribution. The strongest air motion or wind is found just below the stratosphere; and it would seem that pressure changes originate in this region and probably control conditions throughout the lower atmosphere. We may note here the somewhat startling suggestion of Dr. W. N. Shaw* that wind variations may better be referred to this upper level than to the surface. Cave is of the opinion that such a base simplifies the problem. For example, working downward, he finds† that in a certain ascent (Sept. 15th, 1911) the west-east component of air flow decreased from +32 m/s. (meters per second) at a height of 9 kilometers to −8 m/s. at 1 kilometer. This means that the *flow was reversed with approach to the earth's surface.* Similarly the north-south component decreased from +12 m/s. to −10 m/s.

Aerographers, then, may well begin their work with these two volumes by Rotch and Cave. If the titles sound somewhat strange to our ears let us recall the quaint expression used by the Dorset squire, Robert Boyle, in his book published in 1660, entitled "The Spring of Air." This volume undoubtedly marks the beginning of positive knowledge regarding the physical processes of the atmosphere, for, crucial as were the experiments of Torricelli, Pascal, and von Guericke, it was Boyle who showed us that the the air was elastic; and his law of pressure and volume relation, expanded later into the characteristic equation of a pure gas, lies at the bottom of our modern thermodynamics.

We shall appropriate the term "structure" from Cave, for aerography must be, in essence, a description of the structure, or make-up, of the atmosphere. But every structure must rest upon a base; and in aerography it may be necessary to discard the old sea-level plane so familiar to us, but now known to be of somewhat doubtful value, when atmospheric conditions over continental areas are to be reduced downward. How can we get another base plane? It may be remarked at this point that it is a difficult matter to adequately represent atmospheric conditions on a flat map. The daily weather map in its present form—and there has been practically no change in forty years—by no means represents conditions at the bottom of the ocean of air; and perhaps much of the uncertainty of forecasting may be traced to faulty graphics. Again, the aerographer must be able to show on the base not only pressure and temperature gradients, but water-vapor content and, for lack of a better name, dust load, meaning thereby small and large nuclei of condensation, ions, and electrons.

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* *Quart. Journ. Royal Meteorol. Soc.*, vol. xxxviii., 1912, pp. 46-48, and *Nature*, vol. lxxxviii, 1911-1912, p. 141.

† *Ibid.*, p. 10.

And it will be a great step forward when these can be shown for all levels. Then, as a geographer would chart continents, coasts, and islands, the aerographer would chart hyperbars and infrabars—regions of excessive air flow and regions of no flow or stagnation—also levels where the interchange of air was mainly by "advection," or horizontal motion, and where the interchange was by "convection," or vertical motion, using terms introduced by Ernest Gold in his prize essay on "The International Kite and Balloon Ascents."*

With such a base map and such auxiliary charts the winds and clouds will take on a new significance and can be studied to advantage. The layman as well as the expert would be able to follow the general circulation, and follow intelligently the average west-to-east drift around one pole and the reversal at the other. Interruptions and displacements of the great air streams could be correlated with abnormal weather conditions and give us firmer ground in forecasting. At present one must applaud rather the valor of the forecaster than the value of the forecast. Such charts would go far in settling discussions regarding the origin of cyclones and anticyclones, discussions which, so long as they are based upon present charts of air flow, must continue to be unsatisfying.

Returning again to the apparent structure of the atmosphere: as indicated by the models used by Cave, it would seem to be entirely feasible to show the sequence of wind velocities and directions at various levels appropriate to certain types of weather and certain seasonal conditions. Let us also consider Shaw's suggestion of the stratosphere as the principal plane of reference. It may seem strange to attempt to use so variable a level as the base of the stratosphere, yet it may be after all most appropriate, since the atmosphere is itself variable and mobile. The geographer deals with a solid earth, and there is no flow horizontally or vertically. True, we live upon a rotating geoid; but our sensations and impressions are such as would be common to dwellers upon a flat surface. We are handicapped in comprehending air motion because all our experiences are based upon impressions of level and fixed planes. We are, for example, absolutely unconscious of any deflective effect of a moving air current due to the earth's rotation.

It is a peculiar fact about the stratosphere and one full of significance that it does not remain at a fixed height but varies with season and latitude. At the equator, as we rise in air, the temperature continues to fall to a much greater height than in temperature latitudes. Indeed the lowest temperature, probably the lowest natural temperature, is found above the equator. This state of affairs was anticipated by Teisserenc de Bort and Rotch and has now been proven by certain ascensions. This at Batavia, Java, on December 4th, 1913, the sounding balloon reached a height of 26 kilometers, entering the stratosphere at 17 kilometers and recording a temperature of 192 degrees *A* (−112 deg. Fahr.). In other words, the stratosphere is highest over the equator and lowest over the poles, so far as we know.

Expression of air flow, then, is the first desideratum in aerography. The aerographer, however, is at present in something of the quandary in which a geographer would be who depended upon a scale of distance that could be applied only in one direction. A map based on such co-ordinates is, of course, of limited value, and this is true in aerography if we measure only horizontal and not inclined and vertical flow.

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* *Geographical Memoirs, No. 5* (=pp. 61-144) Meteorological Office, London, 1913. Reference on p. 109.

Investigators have been singularly slow in measuring and expressing air flow. Records of horizontal flow date back to the middle of the seventeenth century, or rather began about that time in Italy; but the measurement of vertical flow is still wanting, although W. H. Dines emphasized the need in 1887 and gave us a new form of anemometer. The whole series of wind measurements made in various official weather services throw little light on the vertical movement of the air. And what is still more disheartening, there is a very large error in the horizontal velocities as published.

It is of the utmost importance that we know something or have some way of representing the vertical component of motion of the air. The formation of rain, local and general air drainage, pressure gradients, and temperature gradients are affected by the duration and strength of ascensional and descentional currents. In aeronautics, too, this matter is important. In a recent paper* we find the conclusion that on cloudless days the average upward velocity at the given point was about 0.5 meter per second, while on days with detached cumulus clouds the average velocity was about 2 meters per second.

But the running of the air—to translate literally the old Greek definition of wind—is not a steady, uniform, and continuous motion. On the contrary the flow is frequently of an intermittent character. There are lulls and gusts; and there are eddies and vortices, small and large. This unevenness of flow was brought out clearly by Professor S. P. Langley in his paper on "The Internal Work of the Wind."† In the light of present achievements in aviation it is interesting to read his statement, which seemed so fantastic when written, that an indefinite source of power for the maintenance of mechanical flight might lie in this unevenness of flow, which he called the internal work of the wind. And he adds, what is of some importance in aerography, that "the actual effect of the free wind, which is filled with almost infinitely numerous and incessant changes of velocity and direction, must differ widely from that of a uniform wind such as mathematicians and physicists have almost invariably contemplated in their discussions."‡

In order to illustrate with more detail the structure of the free air as determined by modern soundings, we have borrowed from Cave's book one of the many models shown (Figs. 1 and 2). This represents the wind distribution on October 1st, 1908, seen from the east and from the south. The greatest height in this case was 17.6 kilometers. The diagram (Fig. 5) shows the relation of wind elements to heights.

The structure indicated by Figs. 3 and 4 is that of a typical mid-summer fair-weather day on the New England coast. There was no sea breeze nor even the northeast inflow found frequently under anti-cyclone conditions. The structure is exceedingly uniform. In the lower strata the velocities average from 2 to 6 meters per second, and the flow is fairly steady in direction horizontally. There is a tendency to shift to the north up to about 2800 kilometers, then an increasing westerly component. The sky was practically without clouds. An extensive high area moving east at a nor-

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* Report on Wind Structure No. 4 (for 1912-1913): Papers by J. S. Dines. Meteorological Office, London, 1914.

† *Smithsonian Contributions to Knowledge*, vol. xxvii., No. 2, Washington, 1893. 23 pp.

‡ Langley Memoir on Mechanical Flight, *Smithsonian Contributions to Knowledge*, vol. xxvii., No. 3, Washington, 1911. 320 pp. Reference on p. 42.

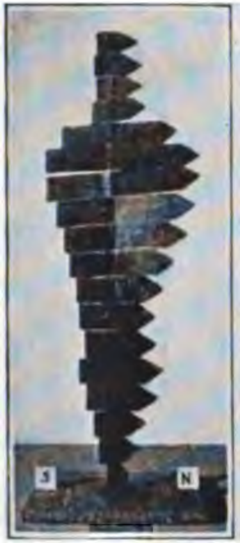

FIG. 1.

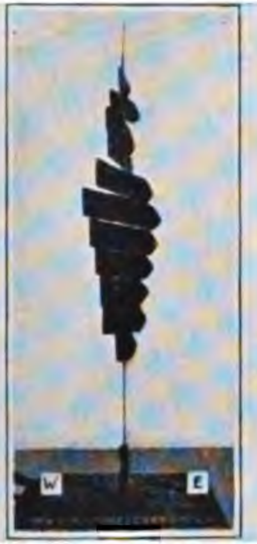

FIG. 2.

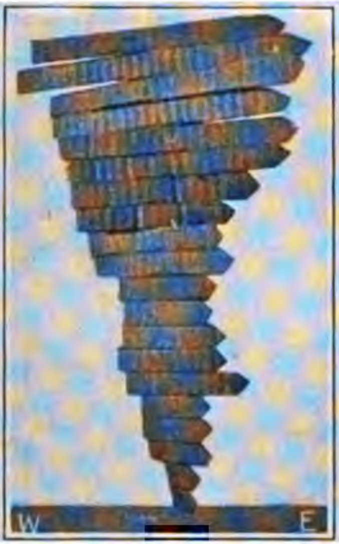

FIG. 3.

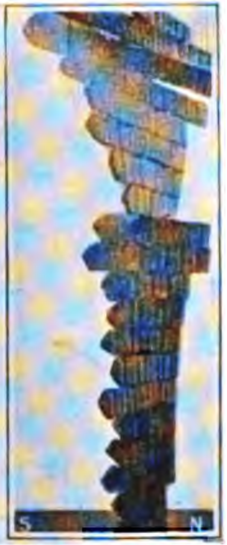

FIG. 4. 1880

MODELS REPRESENTING VERTICAL WIND DISTRIBUTION

FIGS. 1 AND 2 REPRESENT THE CONDITIONS AT DITCHAM, HAMSHIRE, ENGLAND, ON OCTOBER 1ST, 1908; FIGS. 3 AND 4, THE CONDITIONS AT BLUE HILL OBSERVATORY, MASS., ON AUGUST 12TH, 1910. EACH MODEL IS SHOWN FROM TWO SIDES (FIGS. 1 AND 4 FROM THE EAST, AND FIGS. 2 AND 3 FROM THE SOUTH), SO THAT THE ORIENTATION OF THE ARROWS MAY BE SEEN. THE ARROWS FLY WITH THE WIND; THE LENGTH INDICATES THE VELOCITY AT THAT LEVEL. IN FIGS. 1 AND 2 EACH ARROW REPRESENTS AN AIR STRATUM OF 1,000 METERS AND IN FIGS. 3 AND 4 OF 500 METERS.

FIGS. 1 AND 2 ARE TAKEN FROM CAVE'S "THE STRUCTURE OF THE ATMOSPHERE IN CLEAR WEATHER," 1912. FIGS. 3 AND 4 ARE FROM MODELS BASED ON SOUNDINGS MADE AT BLUE HILL OBSERVATORY.

mal rate overlay the eastern half of the United States. In the Ohio Valley and Lake Region the pressure ranged from 1020 to 1025 kilobars. The twenty-four hours following were without rain in Ohio, Pennsylvania, New York, and New England. In fact the day was a typical fair day, and the structure may be said to indicate a certain stability and absence of turbulence.

In general the sub-stratosphere is the region of maximum air motion. Again, the modification of wind direction seems to progress downward.

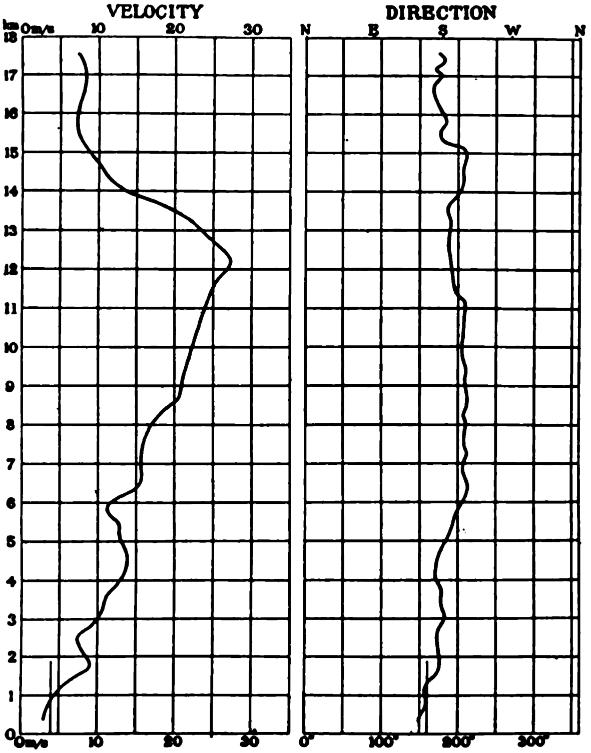

FIG. 5. 1881

DIAGRAM SHOWING, FOR THE WIND CONDITIONS AT DITCHAM, ENGLAND, ON OCTOBER 1, 1908, REPRESENTED BY THE MODEL OF FIGURES 1 AND 2, THE RELATION OF VELOCITY AND DIRECTION TO HEIGHT. BASED ON A FIGURE IN CAVE'S "THE STRUCTURE OF THE ATMOSPHERE IN CLEAR WEATHER," 1912.

THE SOUNDING BALLOON WAS WATCHED UNTIL IT BURST, AND THE HIGHEST POINT DEDUCED FROM THE METEOROGRAPH TRACE WAS USED AS THE HIGHEST POINT FOR WIND OBSERVATIONS; UP TO 4 KILOMETERS THE WIND OBSERVATIONS WERE DEDUCED FROM THE TWO-THEODOLITE METHOD; ABOVE THIS THE BALLOON WAS SUPPOSED TO HAVE A UNIFORM ACCELERATION UP TO THE HIGHEST POINT REACHED, AND THE WIND VELOCITIES WERE CALCULATED ON THE ONE-THEODOLITE METHOD.

Perhaps I can not do better than sum up the impression which such models of structure give than by quoting the words of Dr. W. N. Shaw:*

"It appears that we must regard the sub-stratosphere and the regions above, as the dynamical laboratory of the atmosphere, where the main causes of pressure changes originate, and the troposphere beneath the sub-phere as the physical laboratory of the atmosphere, where cloud,

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Free Atmosphere in the Region of the British Isles: Second Report. By
nes, with a preface by W. N. Shaw. *Geophysical Memoirs No. 2* (=pp. 11-50)
gical Office, London, 1912. Reference on p. 22.

rainfall, and other physical phenomena are produced by local causes, induced, in some cases, by the effect of the dynamical changes in the upper regions."

Thus far we have laid stress on the flow of the air. But temperature and other data are also available. Thus W. H. Dines[*] has given us the normal isopleths of temperature and also pressure from sea level to a height of 20 kilometers and curves showing the local difference from the mean temperature for each level. The Geophysical Institute of Leipzig, under the direction of V. Bjerknes, is publishing a series of synoptic charts for three-day periods of the year 1910 showing the conditions at different levels.[†] The atmosphere is divided into ten principal isobaric levels. In the last number issued, representing the period August 8, 9, and 10, 1910, the stations furnishing soundings were Trappes near Paris, Uccle near Brussels, Pyrton Hill near London, Crinnan near Glasgow, Oughterard on the west coast of Ireland, Manchester, Pavia, Friedrichshafen on Lake Constance, Strassburg, Hamburg, Lindenberg near Berlin, Vienna, Pavlovsk near Petrograd, Nijni-Oltchedaeff in southwestern Russia, and Munich. There were also auxiliary cloud observing and mountain stations. With the data for these stations we can at once construct over Europe the heights in dynamic meters for each stratum of 100 kilobars and also what may be called the relative topography, i. e., the value in dynamic meters between each successive level, or, in other words, the gradient for the aerographic topographer.

Thus the making of aerographic surveys is already under way. Perhaps the day is not so far distant when charts of air structure will be available for consecutive tri-hourly periods for the use of aviators and aerial engineers, for the time is rapidly approaching when problems of transportation *via* air routes must be considered.

—*Scientific American Supplement.*

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THE VISIBILITY OF DISTANT OBJECTS IN WARFARE

The long range of weapons employed in modern warfare has given importance to the study of the appearance of distant objects. A constant contest is taking place between the observer trying to locate the position and numbers of the enemy and the observer who endeavors by all possible means to conceal these factors.

Generally speaking, an object becomes indistinguishable when its brightness and color are identical with its surroundings. For this reason such colors as gray and khaki, which blend well with the surroundings, are preferred for modern uniforms. Yet their effectiveness in this respect depends on the nature of the ground over which troops are moving. Khaki is doubtless difficult to distinguish amid sandy wastes; gray or green might be better against grass or foliage. Of all colors, red is the most conspicuous at a distance. Not only is it the color which presents the most vivid contrast with the ordinary background, but there appear to be certain physiological factors which accentuate this impression. For example, it is well

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[*] *Op. cit.*, sub. 9, p. 29.

[†] Synoptische Darstellungen Atmosphaerisher Zustande: Jahrgang 1910. *Veroeffentl. des Geophys. Inst. der Univ.* Leipzig; Heft 1. Zustand der Atmosphaere ueber Europa am 6. Januar 1910 (Leipzig, 1913): Heft. 2,—am. 2, 3 und 4 Februar 1910 (Leipzig, 1913; Heft 3—am 18, 19 und 20 Mai 1910 (Leipzig, 1914); Heft 4,—am 8, 9 und 10 August 1910 (Leipzig, 1915).

Stabilizer.—The stabilizer is divided and mounted on either side of the body. In design it is of the non-lifting double cambered type. These pieces together with the elevators are quickly detachable from the body.

Propeller.—One paragon propeller, designed especially for this machine and the motor thereon, is furnished with each complete machine.

Rudder.—The rudder frame is of steel tubing and mounted in the conventional way at the rear of the body.

Mufflers.—Exhaust gases are piped away from the motor and discharged beneath the planes, thereby adding greatly to the comfort of the occupants.

Equipment.—The regular dashboard equipment consists of an altitude meter which reads to ten thousand feet, a motor speed indicator, rolling and pitching gauges, oil and air pressure gauges when the motor installed requires the same. A speed indicator which tells the speed through the air will be furnished at cost.—*Aerial Age Weekly.*

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HIGH ANGLE FIRE AT AIRCRAFT

By Sir George Greenhill

This war is full of surprises to our old-fashioned professional soldier. Two years ago he would have denied the practical utility of calculations of long range artillery fire, up into the air at an enemy airship overhead.

In these calculations the work is complicated by reason of the varying tenuity of the air as the shell rises, and the major part of the range where the shell is flying almost horizontally is made in air which may be half the density or so of that at the ground.

Even in ordinary direct fire close over the ground the variation of tenuity with barometer and thermometer has been found to require careful attention, especially where an advance is made under the cover of the friendly artillery firing overhead from the rear. Here a slight variation in air density is enough to make the advance unsafe, unless the tenuity factor, τ, has been carefully estimated. A nomographic chart has been devised by Major Hezlet, on which τ can be read off for given barometer and thermometer, and then translated into the appropriate percentage change of elevation of the gun.

As a preliminary calculation an estimate must be made of the average height reached, and of the mean tenuity of the air, to be taken as uniform over the whole range. These tentative results are useful as a stepping stone, and in checking the more careful calculation, where it is usual to divide the air up into strata of uniform density, say 1000 ft. thick, corresponding to a fall of about 1 in. in the barometer.

The work of making ballistic calculations for long range high angle fire is always tedious and heavy even for the skilled computer, assisted by a scheme of computative details, where the numbers can be filled in. Mathematical interest is absent except in an attempt to justify the daring approximations employed; and the absence of rigor in the method would disgust the modern school of analysis.

The extra complication can then be imagined where the target is not a town stationary at sea level, but an airship in swift movement 10,000 ft. or 15,000 ft. up in the air, seen on a line of sight pointing up at any angle up to 45 deg. and more.

vation, while quadrant elevation was in the mind of the garrison gunner. On such a moderate slope as would occur in practical warfare the alteration in tangent elevation is so small as to escape notice, and so the field gunner backed the opinion of no alteration of elevation, meaning tangent. But quadrant elevation of the garrison gunner requires the addition or subtraction of the angle of sight, an appreciable alteration. So no conclusion could be arrived at, because the two schools were using the same name to denote different things.

The alteration of tangent elevation begins to be appreciable with the high angle of sight required against aircraft. A convenient formula as a good first approximation is called the *Cosine Law*. On this law the tangent elevation for the level is reduced by a factor, the cosine of the angle of sight, to obtain the elevation, firing at the same range, right up the line of sight to the airship.

The rule or law can be justified by supposing the trajectory straight and flat enough for the component of air resistance across the line of sight to be neglected; so that the shell is actuated by two component forces, one of gravity vertically downward and the other air resistance acting down the line of sight. In an analytical geometrical discussion the motion is referred to these two oblique co-ordinates, the vertical and the line of sight.

Having calculated a trajectory of the ordinary range table for the given range along the line of sight horizontal, the ordinates may then be supposed to turn about their feet on the inclined line of sight so as to remain vertical, like men marching up a hill. The trajectory is then foreshortened by the cosine of the angle of sight, and so is the elevation on the back sight to correspond, the tangent leaf remaining perpendicular to the axis of the gun. In some mountain artillery required to move on rough ground and steep slopes, the tangent leaf was suspended by a pivot so as to hang vertical and so give the correction automatically of the Cosine Law.

Although a good working law, it is not strictly accurate, and a slight correction of the second order may be required when the range is considerable to allow for the air tenuity effect.

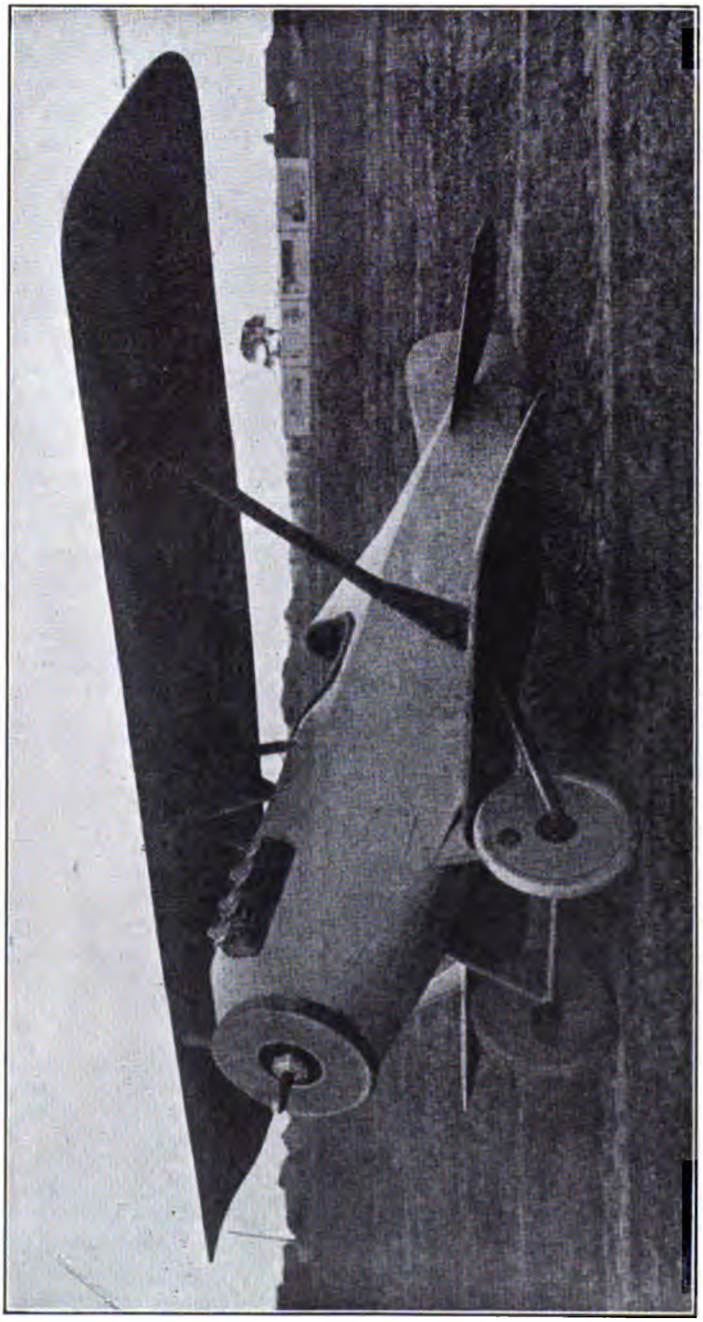
But no hit has been recorded yet at a long range, and it is waste of ammunition to fire, besides giving confidence to the enemy. The probability of hitting becomes too small, and in the time of flight the airship will have moved its own length and more.

The Cosine Law will serve, however, for general explanation and practical use at a reasonable moderate range, especially as the correction for speed of target is of much greater importance than any second order correction of elevation.

Aircraft guns should always be mounted in a brace alongside, like pistols, to check each other and serve for continuous ranging. Too much time is lost if the guns are not close together, for it is difficult to keep the gunners in direct verbal communication, and the attack may be directed on different targets.

Questions pour in on this problem of fire at aircraft, always with insufficient data and obscurely expressed. A complete answer to one of these questions might involve a fortnight's work of a skilled computer, in addition to writing out a complete treatise, only to be told at the end—That is not the question.

But assume a simple normal case of a range of 2000 yards at a height of 3000 ft., an angle of sight of 30 deg. The angle of ordinary elevation



1883

The New Model Curtiss Aeroplane without Wires

Aerial Age Weekly.

in the range table for 2000 yards is, say, 2 deg.; reduce this by the factor cos 30 deg. to 1.7 deg., and with this elevation a good trial shot will be made, near enough for correcting the next shot of the gun alongside, provided the target will oblige by remaining stationary.

The question arises of the influence of tenuity on the rate of burning of a fuse, as affecting the setting of a time fuse, as also the alteration of the time of flight. Experience seems to show that the effect is not noticeable, the influences at work acting to cancel each other.

A good working rule in fire at a moving target, advancing or retiring in the line of sight, is to give extra elevation, say of the full 2 deg. and to aim low, below the target; the target is then sailing through a flatter part of the trajectory, and a hit is more likely to be made.

Suppose, however, the range was increased to 5000 yards; the trajectory would become too curved for these approximate methods to hold. Resource must then be made to elaborate calculations, carried out previously at leisure, and with unlimited time for the trained computer, paid specially for this work. And when the gun is fired, the chance of hitting is so small, it should be held a waste of ammunition. We are not decrying here the utility of such calculations in modern siege warfare, carried out as we have seen at high elevation and long range, with terrible effect, on a stationary town.

But with a moving target like an airship, at long range high up in the air, the correction for speed is of greater importance than the Cosine Law or any other correction of elevation; and the Theory of the Speed Sight will require an article to itself.—*The Engineer.*

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FIRST AEROPLANE WITHOUT WIRES

At the Curtiss Aviation Field, on the Niagara Falls Boulevard, Buffalo, a new and novel type of aeroplane is being demonstrated.

The machine has just been completed under the supervision of its designer, Mr. Glenn H. Curtiss.

It has many refinements and novel features, the principal of which is the entire elimination of exposed wires. The ordinary aeroplane is a network of wire which greatly reduces the speed. In the past some attempts have been made to reduce the number of wires, but wooden posts have been substituted, or the round wires have been replaced by oval or "stream-line" wires. In this machine the number of posts has been reduced to two, one on each side, and not a wire is used in the trussing.

The head resistance, as a whole, has been reduced to a greater extent than in any aeroplane before constructed.

It is a biplane with a 20-foot spread to be used as a Speed Scout, and a maximum speed of 120 miles per hour is expected.—*Aerial Age Weekly.*

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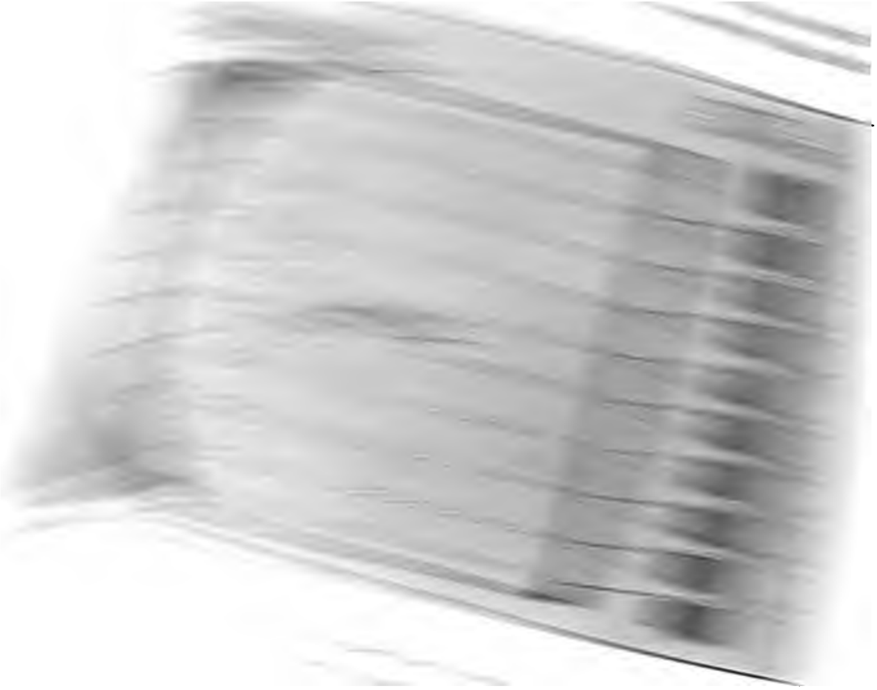
SEARCHLIGHT PROTECTION

In the accompanying illustration is shown a British method of protecting a searchlight when used in exposed positions.



"threw a monkey-wrench into the works" by springing to arms in far greater force than anticipated, with the result that ultimate strategic developments when the German armies were near Paris were delayed for a period just barely sufficient to permit France to mobilize in enough strength to stem the tide of invasion after the official capital had been moved from Paris to Bordeaux.

It was on August 14th that the first large body of French troops could reach supporting distance of the Belgian army, near Dinant. Two days later the comparatively small British contingent reached the lines. At the beginning of the last week of August the British were in position, joining up with the French centering on Namur. The Germans forced the latter contingent back and the British right flank was left up in the air, 24 hours elapsing before Field Marshal Sir John French discovered his perilous position. Immediate retirement was necessary, and a general retreat took place, a marvel of military accomplishment, ending only when the allied lines stiffened and held at the Marne.

This is a fitting place for a moment's digression. The war is not yet ended, and the end is not yet in sight; but every indication points to a growing superiority of Entente over Teuton in men and all-important guns. The perspective of two years, combined with the mathematical probabilities of the future, lead to a constantly expressed opinion by military observers that the decisive battle of the war will not be told in history as marking the close of the war; it will be known as the battle of the Marne, when the German plan to eliminate France at once failed signally.

The German plan of campaign soon became evident. It called for the absolute defeat of the French armies—their elimination—first of all, while Austria and a skeleton army of Germans were to hold mighty Russia in check; the Germans, figuring on the proverbial slowness of Russian mobilization and the scarcity of railway lines, counted that at least two months were available for their mighty stroke on the west; after that they were to turn on Russia with full strength and wipe her out as a military factor. Their plan came very near to success.

September 1st found the Germans extended from the environs of Paris to the Swiss frontier, with von Kluck advancing against Paris proper, obliquely across the front of the fortress. The French center was the objective of the hardest attacks, and it barely managed to hold on. Von Kluck, attacked on his exposed flank, was forced back. French reinforcements, hurriedly recalled from the offensive which had been launched in Alsace for moral effect, were rushed to General Foch's endangered center; and the entire German line pivoting on Verdun was forced back by von Kluck's retirement, until the line of the Aisne was reached and the lines settled into their deadlock which obtained for so long. Gradually the lines were extended in attempted flanking operations until they reached the North Sea.

Even then things might have prospered for the Teutonic cause had Russia not upset all calculations by mobilizing in strength with surprising speed. While Russia was not ready for an offensive movement, the peril of her allies on the west demanded that she take the initiative. Preparations for this movement became so evident that the Kaiser, instead of standing strictly on the defensive in the east, directed the Austrians to invade Poland. There was at first little resistance offered by the Russians, but before long the Austrians were checked and the Russians struck the Austrian

rounded; but again the Russians escaped through a very small gap which was held open by almost superhuman efforts, and the northern portion of the Russian line retired to the strong line of the Dvina. Mackensen bent every effort toward the elimination of the Russian forces in his own front, and he drove them back beyond the Pripet marshes, took Lutsk and Dubno —then his efforts could carry no farther and the eastern front settled down into a condition of deadlock similar to that in the west.

On the western front there occurred little change during this time. There were constant and sanguinary encounters, sorties, little local offensives launched here and there, but with no more effect than the gain or loss of some slight trench positions, which affected not at all the general situation. In September, 1915, the French opened an ineffective offensive in the Champagne and in Artois, attacking over a composite front of 26 miles. The Entente forces farther north sought to supplement the efforts of the Champagne offensive by attacking Lens. But preparations had been insufficient, and while a few miles of ground represented the gain, it had little effect on the situation.

The Gallipoli failure must go in the records of the second year of the war. In the effort to get in closer communication with Russia, to supply her crying needs for munitions, it was decided to attack Turkey at the Dardanelles and open the straits. The Entente naval forces instituted a heavy bombardment without material effect; there was much controversy at the time as to the propriety of the attack, and it now seems very evident that it was ill judged, for the naval attack was begun before the troop contingents were anywhere near ready to be landed, and Turkey—and Germany—were able to prepare for adequate defense.

Due to diplomacy, Bulgaria joined forces with the Central Empires in September, 1915, and in October moved upon Serbia. Mackensen, after the deadlock resulted on the Russian front, went to the Balkans to direct the Teutonic operations and, with a powerful Austro-German force, attacked Serbia from the north, while Bulgaria invaded from the east. Between the two, the Serbs were driven into Albania, and by the last of November every foot of Serbian soil was under the Kaiser's control. A belated effort was made to assist the Serbs by England and France, but as all communications with Saloniki, the landing place, were cut, it was of no assistance. A remnant of the Serbian army was able to reach the sea. This remnant has been reorganized on the island of Corfu and has been transferred to the lines of Saloniki, augmenting the forces under General Sarrail, until at the present time he has under his command a strong force of about 600,000 men, waiting for the propitious moment to strike northward against Bulgaria and the Teutons, in hopes of severing communications between Teutonia proper and Turkey.

Toward the latter part of May, 1915, Italy threw over her allegiance to the Triple Alliance and declared actively for the Entente. Her quarrel with Austria was hereditary, and to her it seemed to offer the only opportunity for the recovery of her lost lands and the establishment of strong geographical boundaries in case of success. The principal effort of Italy was directed toward the Izonzo, and the remainder of the Italian armies struck northward against the Trentino, more as a cover to the eastern operations than anything else. At no time since Italy's entrance into the war have her lines varied much from those of her frontier. Small gains have been made here and there, but not sufficient to bring any material

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l for the manufacture of 13 subcaliber barrel kits for .22 caliber ition for 3-inch field guns, models of 1902, 1904, and 1905.

rill cartridges for 4.7-inch gun.—The order for 24 drill cartridges for h gun (wood body) has been completed.

ROCK ISLAND ARSENAL

Armor plate has been procured and will be attached so as to protect ngines, radiators and gasoline tanks of the Holt caterpillar tractors being purchased from the Holt Manufacturing Company.

Four motor cars have been armored with armor plate for use on the xican border. Two of these armored cars were built from Jeffery chassis two from White chassis. The two Jeffery cars have two turrets each the two White cars have but one turret each.

SANDY HOOK PROVING GROUND

Tests made:—

Elevating clamp for 5-inch siege gun carriage, models of 1892 and 1896, onsidered satisfactory and application to carriages in service recommended.

Watertown Arsenal experimental 12-inch armor piercing shot.—Two ounds fired against a 12-inch Class "A" armor plate (mounted for normal impact) with striking velocities of 1732 and 1748 feet per second respectively. Both shot passed a satisfactory test.

WATERTOWN ARSENAL

New work undertaken:—

Manufacture of 6085 4.7-inch empty common steel shell, model of 1905, for Frankford Arsenal.

Changes in 5 12-inch disappearing carriages, model of 1896, in Northern Armament District, to fit them for 15 degrees elevation.

Manufacture of one 3-inch anti-aircraft mount, Model E.

Manufacture of 1 set of parts for sight standard, for 8-inch disappearing carriage, model of 1896, No. 22, for Fort Rodman, Massachusetts.

Manufacture of 20 sets of parts for modification of elevating mechanism for 12-inch disappearing carriage, model of 1901, to permit 15 degrees elevation.

Manufacture of 29 sets of parts for modification of elevating mechanism for 12-inch disappearing carriage, model of 1897, to permit 15 degrees elevation.

WATERVLIET ARSENAL

Design of an armament chest for 3-inch (15-pounder) gun and mount, Model E (anti-aircraft) undertaken.

Design and manufacture of a block locking device and rotating crank stop for 10-inch gun, model of 1888, undertaken.

BETHLEHEM STEEL WORKS

New work undertaken:—

56 treated armor plates .3-inch thick, for armoring caterpillar tractors, under Rock Island Purchase Order No. 3823.

MIDVALE STEEL COMPANY

New work undertaken:—

One set of forgings for 3-inch (15-pounder) gun, Model E, anti-aircraft, under Watervliet Arsenal Purchase Order dated May 12, 1916.

Short Notes

Direct and High-Angle Fire.—At 45 degrees, and a few degrees above and below this elevation, the shooting of a howitzer is wild, and therefore shooting at the highest angles should be undertaken from 50 degrees upward. At 65 degrees some of the shell fall base first, while at 75 degrees they all fall base first, giving very irregular shooting. Therefore the practical limits for high-angle fire are between 50 and 65 degrees of elevation. Gen. Rohne reckons that the lateral dispersion is in direct proportion to the time of flight, that is, about double the dispersion with direct fire; the dispersion in depth is, however, not much greater. The striking velocity is much the same as with direct fire, but the penetration against a horizontal target is from 2 to 5 times as much as with direct fire. Therefore for penetration it pays to use high-angle fire at over 50 degrees elevation, while for accuracy it pays to use the lowest elevation that will reach the target. —Extracts from *Précis of Artilleristische Monatshefte* in *Scientific American Supplement.*

Powder Pressure in Guns.—The 42-centimeter and other big guns, so often referred to in this war, are howitzers, of low velocity (say 1000 to 1500 feet per second) and using low powder pressures in the powder chamber of about 14 tons to the square inch. The high-velocity naval and coast defense guns have velocities of from 2500 to 3000 feet per second, and powder pressures of 18 to 20 tons per square inch. J. A. Longridge, the father of the wire-wound gun used so extensively by the English, stated many years ago that guns could be built to stand 30 tons pressure. Maybe; but what about the attendant erosion?—*Scientific American.*

Artillery in the Austro-Italian Offensive.—In the great offensive by Austria against the Italians, reliance was placed upon her enormous concentration of artillery. Allowing that seven army corps were engaged in the attack, the normal equipment of artillery would have been 1300 field pieces, 216 4-inch field howitzers, and 56 6-inch howitzers. Hillaire Belloc in an interesting analysis of this question states that the Austrians tripled the number of 4-inch and 6-inch howitzers; that they had four 15-inch and four 16½-inch howitzers; and that the total number of guns was 2422. He makes the point that because of the limited railway accommodation, it will take the Austrians in their retreat several weeks to remove to another front this mass of heavy artillery and its enormous stores of ammunition.

—*Scientific American.*

A Machine for Digging Trenches.—The Germans have made use of a Belgian machine for digging canals as a trench digger. In one minute it excavates a cubic meter of ditch. In favorable ground it can advance over 100 yards in an hour, which is equal to the work of 200 men with pick and shovel. It can be employed only well to the rear of the firing line.

—*Scientific American.*

Infantry Steel Helmet Has Come to Stay.—The reintroduction of the medieval steel helmet by the French has been followed by its adoption by the British and the Germans. The helmet is being issued to the British troops at the rate of 50,000 a month. It is flatter, or of lower pitch, than the French helmet and has no flutings. Between the helmet and its double lining of felt and wadding is fixed a number of rubber studs, which take up the shock of a blow. The wadding comes next the head, so that in case of penetration and a resulting scalp wound it acts as a dressing.

Great Defensive Strength of Battleships.—A careful reading of the many accounts, official and private, which have been published, describing the battle of Jutland, leaves a strong impression of the wonderful defensive qualities of the modern battleship. Because of the misty weather, battleships came under fire at ranges as short as 8000 and even 5000 yards, when salvo after salvo was landed upon the opposing ships. There is a saying among our naval men (or rather there was before this great fight) that the first salvo to land upon the enemy would practically decide the fight—so demoralizing would be the burst of a few high explosive shells within the ship. Nevertheless, Admiral Jellicoe speaks of one of his ships as landing seven successive salvos upon a battleship of the enemy, which apparently survived the ordeal, since the report speaks of her as having "turned away," probably to get out of range; and there is the case of the *Warspite*, which, with broken steering gear, became the target for six battleships of the enemy and nevertheless effected repairs and rejoined the British fleet. Then again, the *Marlborough*, although struck by a torpedo, continued in the fight and landed her salvos with effect.—*Scientific American.*

Ships Proof Against the Torpedo.—Commander Charles N. Robinson, R. N., in a recent description of the British monitors, states that just below the surface the sides are made to bulge out some ten feet and then to curve in. A torpedo striking this bulge will explode amidst a variety of substances, and in all probability will do no damage to the hull. The system has been applied also to some of the old cruisers and to many new ships, including mine sweepers. The armament of the new monitors, by the way, consists in some of 14-inch guns, in others of 9.2- and 6-inch guns, while others carry only the 6-inch.—*Scientific American.*

5000-Ton Submarine Cruisers.—The *Frankfurter Zeitung* quotes the following from an article in the weekly technical paper *Prometheus* on new submarines and diving cruisers:—

Reports have been lately every more persistent that the two foremost naval Powers have begun building regular submarine cruisers. These vessels are of 5000 tons gross, are 400 ft. long, and are as strongly protected and armed as medium-sized protected cruisers. They have engines of 18,000 horse-power, developing a speed above water of 26 and under water of 16 knots. Their effective radius is from 18,000 to 20,000 nautical miles, and they are capable of travelling from the Baltic to Japan without replenishing their fuel. They carry 30 torpedo tubes and two reserve torpedoes for each tube (90 torpedoes in all), and several light and medium quick-firers for defense against aircraft.

The journal says:—"The most terrible weapon, however, which the submarine cruiser will have, in addition to the torpedoes, is the apparatus already introduced with such great success in submarines for laying submerged contact mines, of which each of these strange vessels will carry from 125 to 150."—*The Engineer.*

BOOK REVIEWS

The Engineer in War. By Major P. S. Bond, C. E., U. S. A. New York: McGraw-Hill Book Company, 239 West 39th Street. London: Hill Publishing Co., 6 & 8 Bouverie Street, E. C. Agent: Journal U. S. Artillery, Fort Monroe, Va. 5" x 7½". 187 pp. 70 il. Flexible cloth. 1916. Price, $1.50.

In a democratic country like ours the obligation to serve ought to walk hand in hand with the rights to vote, to freedom, and to opportunity. But there is a wide gap between the things that are and the things that ought to be. And in America, while one hears much about the rights and privileges of American citizenship, the soft pedal somehow appears to have been put on all notes sounding the call to duty. We are a people glutted with rights and void of duties. While recently the advocates for universal military training and service have been able to secure a hearing the Army still remains a body too small for adequate defense, even when reinforced by the less trained troops of the National Guard. As conditions now exist the nation must continue to rely upon the volunteer in time of war. Any training or preparation is desirable which can make that volunteer more efficient in advance of the call upon him.

Perhaps every civil engineer and every contractor in the land has at one time or another figured how in time of war, if he volunteered for service, he would seek his opportunity in the Corps of Engineers. And in that corps he would probably find his greatest opportunity for with the expansion of the military forces that war conditions would demand there would exist many vacancies in that corps to be filled. And in that corps the civil engineer and the contractor would render his greatest service because he could be most useful in adapting his civil professional knowledge and experience to military needs. But there would exist the necessity for an adaptation of his science to new conditions. Problems would have to be viewed from a new angle, work would have to be planned on a new basis. Therefore, if the civil engineer or contractor is to be of military service in time of war, he must "in time of peace prepare for war." He must learn in advance how the military problems are solved.

Major Bond, in the book under review, has sought to give the civil engineer and the contractor the view point from which military engineering problems must be determined. He clearly emphasizes the differences between the methods and economics of civil and military engineering. Thus, where the civil engineer builds for posterity the military engineer plans for the exigency of the moment, and the latter's work, therefore, is characterized by makeshifts and temporary expedients, in sharp contrast to good civil practice. And where in civil engineering first cost is the element of prime importance and time is important chiefly as it affects the first cost, in military engineering time is the matter of first consideration and "any cost will be

ults in a saving of time at a critical juncture." Simplicity
, and the use of simple sketches instead of formal plans,
ferences in the methods of the military engineer as against
vil engineer. Of course these differences will not be present
military structures built in time of peace, or built away from
war.

element with which the military engineer must be familiar
the civil engineer will generally know nothing, is the adapta-
ary works to the tactical needs of the troops affected.

hese differences between the two professions developed in his
er on "General Duties of the Military Engineer," the author
to discusss the work of the military engineer in a more detailed
work he classifies as

1. Transportation,
2. Fortification, and
3. Sanitation.

he head of "Transportation" Major Bond includes two chapters,
"Stream Crossings" and the other on "Military Roads." In dis-
these topics he illustrates in a practical way how different the mili-
lution is from the civil solution of the problem. Later an interest-
apter is devoted to "Field Fortification and Siege Operations," while
bject of "Military Sanitation," with its temporary and occasionally
or less permanent problems, is made the subject of another chapter.

As the book is frankly intended to give a perspective of the scope of
tary engineering, particularly field engineering, rather than to attempt
over the subject in a technical way, already quite fully treated in exist-
manuals and text books, only suggestions of a general character are
luded within its covers. This gives an opportunity for other chapters
d in addition to a chapter on "Tools and Equipment Employed in Mili-
ry Engineering," quite appropriately placed among the early chapters of
he book, are the later chapters on "Military Demolitions," "Military Reconnaissance, Sketching and Serving," "The Mobilization of Resources," and "How May the Engineers and Contractors of America Prepare to Meet the Military Obligation of Citizenship." The suggestions contained in the chapter on "The Mobilization of Material Resources" are already being given effect through the active co-operation of the Engineer Societies in America.

The book is primarily addressed to the civil engineers and contractors in this country in the hope of arousing their interest in the very important question of national defense, and in stimulating them to seek some form of military training suited to equip them for volunteer service. The book, however, will prove of interest to all militia officers as well, particularly as a primer or introduction to the more technical study of field fortification, transportation and map making. The layman too, though without technical engineering or military knowledge, will find matters of interest in this book which will throw light for him on those engineering features of warfare with which the present European war has made him somewhat familiar.

The book closes with a bibliography for further reading and a glossary for immediate use.

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The Making of Modern Germany. By F. Schevill, Professor of Modern European History in the University of Chicago. Chicago, Illinois: A. M. McClurg and Company. 5½" x 8". 259 pp. 8 il. 2 maps. 1916. Price, $1.25.

This book consists of a series of lectures delivered by the author in 1915.

In the first lecture is described the rise and fall of what is called the elder Germany. It is shown that this Germany "was *passionately Christian*, was *agricultural* and was *monarchical*." The nation was better organized, probably more prosperous, certainly more powerful and possessed of greater international authority than her two western rivals, England and France. A great and brilliant future should have been in store for her. That the reverse was the case is attributed first to the hostility between the German Emperor and the Pope, which resulted in many wars, and finally to the Thirty Years War which when over "left behind a devastated country and an utterly exhausted people."

The war ended in 1648 and this is the year the author takes as the "effective starting-point of the new Germany."

The rise of Brandenburg is then described. Its ruler known as the Great Elector "felt that without a compact government, the social order and co-operation which were necessary after the long anarchy of war could not be attained, nor the assurance be given to peasant and citizen that they would enjoy the product of their labor. Under the system he had in mind, the taxes assessed according to law would flow into a central treasury and be applied by state officials to genuine community ends, such as justice, roads and canals, forests and mines, and finally an army."

The central administration and strong army resulting from the application of the ideas of Brandenburg's ruler produced a wonderful recuperation and the author shows that the principles believed in by Frederick William followed as they have been by his successors on the throne of Germany have made that great country what it is.

The second lecture deals with Frederick the Great and the advent of Brandenburg now called Prussia as a European power.

After describing the prince's early life, his clash with his father followed by his Spartan training, the author tells how "without denying his love of letters, Frederick II. lived and moved from the first day of power in the traditions of the Prussian crown, and recognized as his main task the support and enlargement of his inherited state."

Then follows a reference to the rivalry with Austria, the wars engaged in by Prussia, and the methods adopted by Frederick to develop the manufactures of his country.

It is made "clear that Frederick the Great was the dominating figure in the eighteenth century history of Prussia."

The third lecture discusses Napoleon Bonaparte and Prussia's overthrow and reconstruction.

It is pointed out that "the Revolution, an event of the utmost logic, in fact a necessity, in France, could not even be understood in Prussia, and gave rise to the gravest fears." Consequently, "Prussia identified with the old régime, naturally and spontaneously ranged herself on the side of France's enemies."

The man that followed Frederick the Great, however, was not a sold[illegible] and finally after Jena the "whole Prussian state fell like a house of card[illegible]

But fortunately for Prussia, there were a Queen Louise and such men as Stein, Hardenberg, Scharnhorst, Gneisenau, and Humbolt and full credit is given them for their great work in the cause of their country.

The narrative then shows that "the Prussian army figured prominently in both the first and second overthrow of Napoleon Bonaparte."

The fourth lecture begins at the close of the Napoleonic period and the position of Prussia at this time is attributed to "the social transformation wrought by Stein and the other patriot statesmen" and also to the results of the Congress of Vienna.

In this lecture is discussed the progress and reaction from the Congress of Vienna to the revolution of 1848.

Among the achievements of this period, were the co-ordination of the Prussian schools into a comprehensive national system, the adoption of a new economic policy, the creation of a tariff union with the other German states, the gaining in the universities of an honored standing for the natural sciences, and the adoption of a constitution. But, as the author shows, the progressive element were not satisfied and a serious revolution was narrowly averted, the various states of Germany remaining more or less apart.

It is then as described in the fifth lecture that Bismarck appears. His efforts to consolidate the nation are traced through the wars with Denmark and Austria, the incident of the Spanish succession, and finally the war with France.

While the Spanish incident "dropped the match in the powder-barrel," the author shows that the cause of this war came from the determination on the part of France to prevent the unification of Germany and to the equally determined will of Bismarck and the majority of the German people to effect this unity. In other words the old familiar subject of the balance of power was the true origin of the war.

The sixth and last lecture is concerned "with the story of Germany since her unification in 1871."

This lecture of all the others should be carefully read by Americans. Professor Schevill considers that the "modern German state constitutes a fusion of the principles of authority and democracy" and he claims that while all Americans recognize and many denounce the authority, they often willfully ignore the democracy which he states is the undeniable yoke-fellow of authority.

He points to the advantages claimed by the Germans for their system as, for instance, the high character of the administration, the fact that all administrative posts are open to the citizens who can pass the required examination, the consequent governing by experts, and the continuity of the administration as contrasted with those abrupt changes that occur in countries where a popular election or an adverse vote checks and even paralyzes necessary public business.

The *Verboten* signs that enrage the lawless American and other self-assertive individualists do not affect the communistically minded German because "he appreciates the value of order, and recognizes that individual compliance with social regulations furthers the good of the whole."

It is shown that immense pauperized masses are a feature of every purely competitive society and that while there is poverty in Germany there is no pauperism.

Passing to the international policies of the country the author describes

Bismarck's efforts to conciliate Russia and Austria, the formation of the Triple Alliance and the never ending efforts to keep France isolated.

Then comes Bismarck's dismissal, the Dual Alliance and finally the Triple Entente.

After this German Kultur is discussed and here we are again reminded that Professor Schevill stated in his preface that he offered "no apology for treating with sympathy 'The Making of Modern Germany.' "

Following the lectures are appendices on the German Emperor, the Reichstag and Landtag, the Polish Question, the Ems Despatch and the Alsace-Lorraine Question.

The appendix on the Ems Depatch is particularly interesting as Professor Schevill's treatment of the subject is different from that of most historians. This may be due to the sympathy referred to in his preface.

◆ ◆ ◆

Instruction on the Lewis Automatic Machine Gun. By "Simplex." London: Foster Groom & Co., Ltd., 15 Charing Cross, S. W. 3¾" x 5¼". 143 pp. Numerous illustrations. Board cover. Price, 2*s* net.

This is a little book of about one hundred and fifty pages 3¾ x 5 inches in size. It is convenient for carrying in the pocket and contains much that is interesting. It is divided into two parts.

Part I treats of the mechanism of the gun and the drill which is covered in nine chapters. The chief features and parts of the gun are fully described. The method of assembling and stripping, the adjustments, and a number of hints as to what to do before, after, and during firing are given. A feature of great value is a table headed "Stoppages" which gives the probable cause and remedy for failures of the mechanism to operate. The last chapter of this part gives the gun drill.

Part II is divided into thirteen chapters and treats of the handling of the gun. Among the things covered by this part are: the duties of the members of the machine gun section, signals in use, methods of fire, uses of the machine gun in open and in trench warfare, a program for training, methods of range taking, and emplacements for the Lewis gun.

The book is short, concise, and easily read. For a short treatise on machine guns in general and the Lewis gun in particular it is excellent. A number of good illustrations and cuts are interspersed through the book.

◆ ◆ ◆

The Mounted Rifleman. By Brig.-General James Parker, U. S. Army. Menasha, Wis.: Geo. Banta Publishing Co. 6" x 9½". 164 pp. 1 il. Price: Cloth, $1.00; Paper, $0.60.

This book is the carefully thought out and logical development of the idea expressed in the first sentence, viz., "The decisive power of cavalry lies in its mobility and its rifle."

The title and the following discussion will undoubtedly surprise many people, coming as it does from the pen of an energetic and distinguished officer of cavalry who formerly was supposed to put all his faith in shock action and the "sharpened sabre."

General Parker bases his study on the cavalry of the Civil War and of the Boer War rather than on the cavalry of Wagram and Waterloo.

An early chapter describes cavalry in the attack and refers to the similarity of the charge and a stampede of horses. Then from this similarity are deduced the proper formations and methods for conducting the charge.

Several chapters are devoted to garrison training. This subject is covered in detail and describes the methods prescribed in a brigade commanded by the author.

As our armies will be largely composed of green organizations, this part of the book will be of great value. It is undoubtedly the result of long experience and the methods described are known to have produced excellent results.

After garrison training, field instruction is described. Here, again, we find methods that have been successfully followed and it is believed that the "Combat Exercises" will prove of particular value and assistance to officers who have not had experience in such work.

There is a timely chapter on "Hasty Training of Volunteer Cavalry," another on "Conservation of Mobility in Campaign" and the last chapter contains "Lessons from the Great War."

Finally, the last sentence contains the principle which the author apparently believes should control all cavalry training, that is, cavalry should move with the speed of horsemen and fight with the determination of infantry.

◆ ◆ ◆

Explosives. Their Manufacture, Properties, Tests, and History. By Arthur Marshall, A. C. G. I., F. I. C., F. C. S., Chemical Inspector, Indian Ordnance Department. Philadelphia: P. Blakiston's Son & Co., 1012 Walnut Street. 8" x 10". 625 pp. 137 il. 1915. Price, $7.00.

This is a book of 625 pages. It is a general treatise of the entire subject of explosives and does not claim to describe every detail of manufacture and use. The subject is too vast to be covered in a single book of moderate size.

The need for a book of this character is well set forth in the opening paragraph of the Author's preface. "Since the late Mr. Oscar Guttmann published his work on the manufacture of Explosives in 1895 no comprehensive book on this subject has appeared in English. In the interval the explosives industry has undergone many changes: every branch of it has developed enormously; even that of black powder; and scientific investigations have thrown light on many of the problems that arise in the manufacture and use of explosives. Especially during the last few years many obscure points have been cleared up."

The book fulfills a long felt want for a treatise on explosives from the point of view of the general user. It is of special value to the line officer charged with the care and use of explosives. Part X is devoted to the construction and location of buildings and magazines and stability, and the tests for stability.

The text is profusely illustrated with some 136 cuts and diagrams showing manufacture, use, methods of testing, and results of explosions.

It is believed that this book would be a valuable addition to the professional library of all coast artillery officers.

◆ ◆ ◆

Bosquejo de la Campana Turco-Balkanica de 1912-13. Compiled under the direction of the War Ministry by the commission of the General Staff Corps which followed the operations on the terrain. Madrid, Spain: Jefe del Deposito de la Guerra, Cuerpo de Estado Mayor del Ejército. 7½" x 10½". 407 pp. Numerous illustrations.

This book is not and does not claim to be a complete history of the Turko-Balkan War of 1912-13. A complete history can be written only after the general staffs of the countries engaged have compiled and published their despatches and other records of the operations.

The value of these notes is in their having been compiled from the reports and notes made by trained military observers on the ground. They seem to be very extensive and quite complete, covering some four hundred pages.

The first chapters deal with the causes of the war and the physical geography and characteristics of the theater of operations. Then is described the military organization and the operations undertaken by the armies of each of the four Balkan States in turn: Bulgaria, Servia, Greece, and Montenegro.

A number of good maps and cuts of photographs showing views of interest during the operations, lend value to the work. On the whole, to one who reads Spanish, this book is a valuable addition to a military library.

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Journal of the United States Artillery

November-December 1916

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1916

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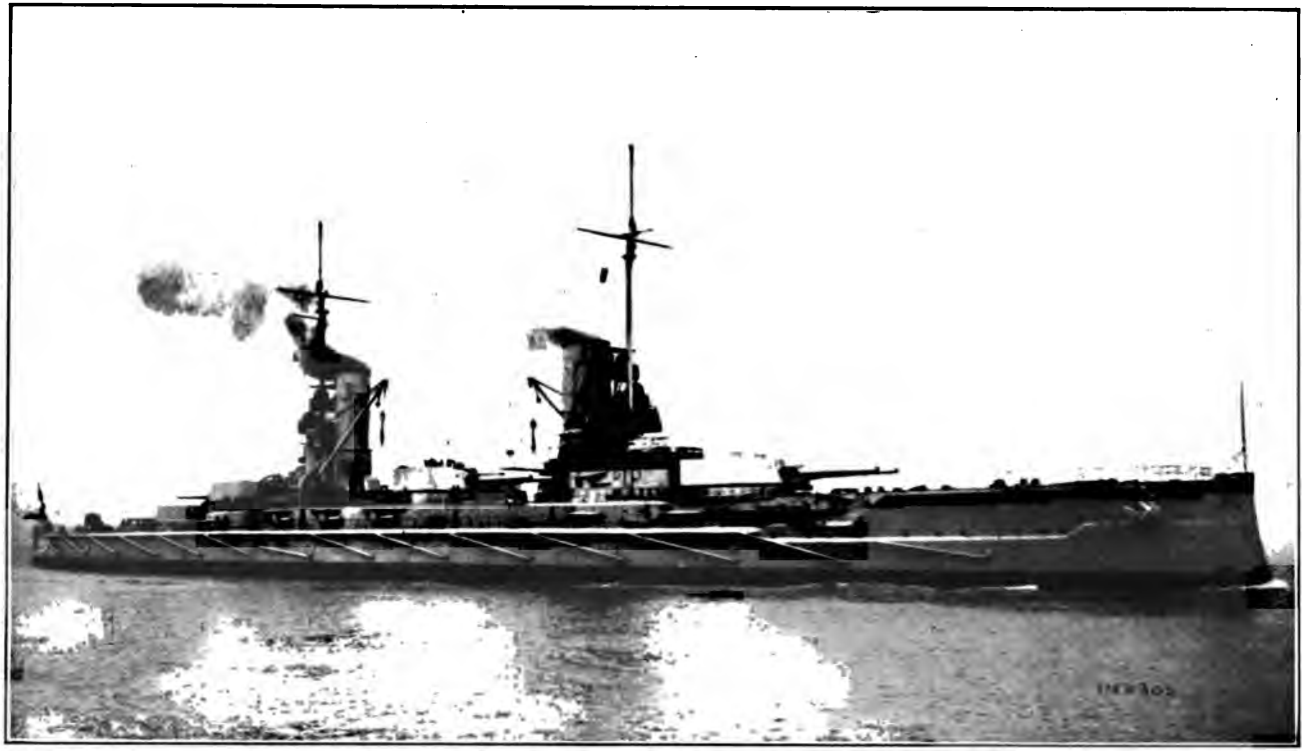

Photograph by Underwood and Underwood.

The German Battleship "Friedrich der Grosse"

Completed October, 1912. Displacement, 24,700 tons; length (water-line), 564 feet; beam, 95 1-2 feet; maximum draught, 27 1-4 feet. Armament: ten 12-inch (50-cal.); fourteen 6-inch, twelve 24-pdrs., four 14-pdrs. (anti-aerial); five torpedo tubes (20-inch). Armor (Krupp): 14-inch belt (amidships), 6-inch belt (bow), 5-inch belt (aft); 12-inch turrets, 7-inch battery. Designed horse-power 25,000 = 20 knots. Complement, 1088. (Jane)

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THE DIESEL ENGINE

BY CAPTAIN CHAUNCY L. FENTON AND LIEUTENANTS LINCOLN B. CHAMBERS AND ROY R. LYON, COAST ARTILLERY CORPS

(Extracts from thesis prepared at the Coast Artillery School.)

FUNDAMENTAL PRINCIPLES

The Diesel engine is one of the many types of internal combustion engines. It is distinctive in its method of operation and, as to the fundamental principles, stands in a class by itself. It operates on what is known as the Diesel cycle.

In leading up to the Diesel cycle it is well to consider briefly the other cycles possible in internal combustion engines. These are:

1. Constant temperature cycle: where the working fluid receives heat at constant temperature and rejects heat at some lower, but constant, temperature.
2. Constant volume cycle: where heat is received into the cylinder at constant volume and rejected after expansion at constant volume.
3. Constant pressure cycle: where heat is received at constant pressure and rejected at constant pressure.
4. Diesel cycle: the practical Diesel cycle does not correspond to any of the above, but is a combination of 2 and 3. The Diesel cycle receives heat at constant pressure and after expansion rejects heat at constant volume.

Of the different cycles mentioned only those will be considered and discussed that are of common interest in dealing with internal combustion engines. No. 2, the constant volume cycle, is commonly known as the Otto cycle. The efficiency, E, for the Otto cycle may be shown to be,

$$E = 1 - \left(\frac{1}{r}\right)^{\rho - 1}$$

where r is the ratio of compression; ρ is the ratio of specific heat at constant pressure to the specific heat at constant volume ($\rho = C_p \div C_v$).

In the Diesel cycle, the efficiency may be shown to be,

$$E = 1 - \left(\frac{1}{r}\right)^{\rho - 1} \frac{R^{\rho} - 1}{\rho(R - 1)}$$

where R is the ratio of the volume of the gas at the point of cut off of heat to the volume at the point of receiving heat. This would probably be more clearly expressed if we consider the two volumes to be that represented by the volume of a steam engine cylinder at the points of cut off and admission respectively. The factors, r and ρ, are identical in both formulæ. The value of the last factor is always above unity.

It is evident from the above formula that the theoretical efficiency of the Diesel cycle is less than that of the well-known gas engine, Otto cycle. The value of ρ, although varying slightly with different mixtures, for most practical comparisons may be taken as 1.4. The value of R, and of r, can be determined for any type or design of engine, and we then have available data for comparing theoretical efficiencies. Although the theoretical efficiency of the Diesel cycle is less than that of the Otto cycle, in practice the Diesel engine obtains a much higher efficiency than can ever be obtained by gas engines operating on the Otto cycle on account of the increasing value of r as the initial compression is raised. The Diesel engine compresses air only; therefore the compression is not limited to the temperature of combustion of the mixture in the cylinder, as is the case with gas engines operating on the Otto cycle.

The Diesel engine operates on both the 4-stroke cycle and 2-stroke cycle; that is, completing one cycle in 4 strokes of the piston (2 revolutions of the fly wheel), or completing the cycle in two strokes of the piston (one revolution of fly wheel).

The 4-stroke cycle consists of first sucking air into the cylinder at atmospheric pressure. The second stroke compresses the air to about 450 or 500 lbs. per square inch and the temperature is raised from 1000 to 1200° F. During the third stroke oil is injected into the cylinder under pressure of from 750 to 850 lbs. per square inch. The fuel is cut off at no later than 1/10 stroke; combustion is completed and expansion continues throughout the stroke. The fourth stroke exhausts the burned gases.

The two-cycle Diesel is different from the 4-stroke cycle in design and construction, but not in theory. The operation of the cycle is as follows:

During the first stroke the exhaust ports are opened just before the piston reaches the end of the stroke, and the exhaust gases are expelled by scavenging air at from 4 to 7 lbs. pressure. As the piston moves up, the ports are closed and the air compressed. Near the end of compression fuel is injected and cut off at about 1/10 stroke, completely burned and expands until the exhaust port opens.

Types, Classification, Etc.

So far the Diesel engine has found a useful field in only two general classes of power producers, that is, marine engines and stationary engines.

It is being tried for direct driven locomotive purposes, but the practice is yet in its infancy and very little data is available on this subject. Diesel engines operating large generators, the current from which in turn drives motors geared to the drive wheels of the locomotive, are a talked of possibility and discussed in engineering papers abroad. There are also some small portable engines operating on the Diesel principle, but they are so few, and data concerning them so meager, that they will not be considered here.

MARINE DIESEL ENGINES

An excellent article[1] on "High Power Diesel Engines: Their Development for Marine Service" by James Richardson, D.S.C., A.M. Inst. C. E., accompanies this thesis. The article is instructive from a standpoint of development for both the marine and stationary Diesel engine.

STATIONARY DIESEL ENGINES

Diesel engines for stationary power purposes may be further classified as horizontal and vertical types, single acting or double acting, and four-stroke or two-stroke cycle. Of the above types we see very little of the development of the horizontal, or of the double-acting type engine. Some few double acting Diesel engines in large sizes for land work (500 b.h.p. per cylinder end) have been constructed in England, and reports seem to show that they have been as successful as the single acting engine. The single acting, four-stroke cycle, vertical Diesel engine has taken the lead over all other types in development and use. Engines of this type are constructed giving from 25 to 1000 b.h.p. per cylinder. The construction of these engines will be taken up in only a general way.

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[1] Not reproduced.

Design

The vertical Diesel is usually of the "A" type framing with enclosed or partially enclosed base. Bed plates are of heavy construction, carrying the main crank bearing. The weight of this type of engine varies from 300 to 350 lbs. per b.h.p. (English practice). Engines of this type are designed with the trunk piston and also with additional guides or shoes to relieve the piston from excessive wear. For small and medium size engines the trunk piston is in general use.

Cylinders

In reference to cylinder design and to the many types used by different makers, attention is invited to the appended article[1] by Mr. Richardson, page 8, including cuts.

A satisfactory solution of the cylinder problem has not yet been reached. Cast iron is holding its place at the top of the list above all other metals for Diesel engine cylinder construction. A satisfactory material for cylinder heads and liners must possess the following qualities:

1. Resistance to growth.
2. High tensile strength.
3. Hardness.
4. Shock resisting properties.
5. Machining qualities.

It is to be noted that the first and most important quality is resistance to growth. Growth is a deterioration of the structure of the metal, due to the rapid fluctuations of temperature to which it is subjected. For further discussion and table showing percentage of growth for various cast irons, see page 10, Mr. Richardson's article.

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[1] Not reproduced.

The advantages and disadvantages of particular types of cylinder construction, especially so far as pertain to head and liner, are discussed by Mr. Cummins on "Diesel Engine Design." (See article attached.)[1] Attention is also directed to the Hesselman patent cylinder head and liner, the method of cooling, and the claims set forth by the inventor.

Pistons

The Diesel engine, operating as it does on high compression, must of necessity have a close fitting piston and a larger number of rings than are usually employed in other types of engines. Due to the high temperatures in the Diesel engine cylinders, it becomes necessary to cool the piston in engines of the larger sizes; especially is this true of the two-cycle and double acting engines.

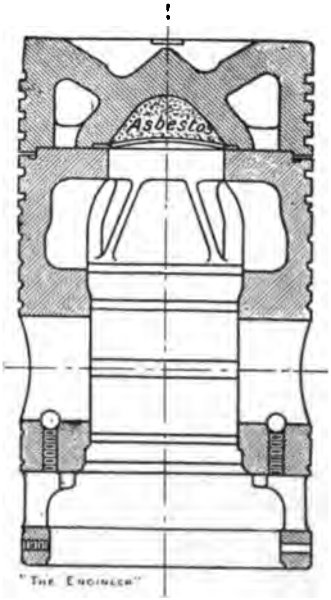

Fig. 1. 1886

The difficulties of piston design may well be appreciated by referring to the sketch (Fig. 1) of one of the most recent developments in this line. This information comes from Mr. G. E. Windeler, chief engineer for Mirrlees, Bickerton, and Day, Limited. This company has had trouble with their pistons, both from casting strains and overheating, and their latest type is that shown in Fig. 1. The piston is made of two parts. It is seen from the illustration that support is given to the crown of the piston by means of a cone thrown down to meet the flange on the top of the lower part of the piston. The cone and connecting walls are made thick and are relied upon to convey the heat from the crown to the walls of the piston. The asbestos is to prevent the direct heat of combustion from radiating on to the gudgeon-pin. This type of piston allows the use of two materials in construction: a heat-resisting mixture of cast iron being used for the head; while a wear-resisting mixture is used for the skirt, or lower part.

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[1] Not reproduced.

At the present time most of the Diesel engines in operation use air compressed to a high pressure (750 to 1000 lbs. per square inch) for atomizing and forcing the fuel into the cylinders. In practical operation it has been found to be the case that about as much trouble was experienced with the compressors as with the engine itself. The method of supplying this air, also air for starting, is by compressors of the single stage, two stage, or three stage type. The single stage compressor is very little used, due to the high pressure required. Air compressors are either driven directly from the engine, or separately driven and usually by motors. No attempt can be made here to discuss the different types of compressors from a standpoint of efficient operation and design; but it will be stated that for engines using compressors, this piece of apparatus may well be considered the heart of the engine and an exhaustive study should be made before the adoption of any one type.

Engines are being operated without blast air, that is by solid fuel injection. In this method there must be increased complications involved in the fuel oil pump. The pressure for atomizing and forcing the fuel into the cylinders is supplied by the pumps. The only cases on record of such operation show a slightly higher fuel consumption than where air is used.

Governing

The governing of the Diesel engine is most commonly done by regulating the amount of oil fed into the cylinders. Attention is invited to the accompanying copy[1] of United States patent issued to Rudolph Diesel, for an apparatus for regulating the fuel supply of internal combustion engines. This same principle is almost universally employed in governing these engines. Another method of accomplishing a variable fuel supply is to change the stroke of the pump or vary the volume of the pump chamber. The speed regulation under load for the Diesel engine is as good as can be accomplished with other prime movers, but at no load there are difficulties in getting close regulation. This trouble is so apparent that the question of synchronizing alternators becomes a serious one. This effect of hunting on no load seems to be due to over sensitiveness of the governor and is a question confronting the engineers today.

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[1] Not reproduced.

Fuel Injection

Attention is invited to the two copies of patents herewith[1] on the fuel injecting nozzle and vaporizer for internal combustion engines by Knut Jonas Elias Hesselman of Sweden. The fuel injecting valve is operated from the main cam shaft. The time that this valve is open does not vary with different loads, but is constant. This valve requires regular attention and cleaning in order not to give trouble.

Cooling

Due to the high temperatures in the cylinders (mean temperature varying from 1100 to 1200° F) the necessity for cooling is obvious, and the failure of the cooling system for only a very short interval of time will result disastrously. The cooling water is usually supplied by a pump direct driven from the engine. By this system it is seen that as soon as the engine is shut down the flow of cooling water ceases, and it is now a recognized fact that this system is defective and that some means should be supplied by which the cooling water can be kept circulating through the cylinder jackets for a short time after stopping the engine. With an independent water supply the engine is gradually cooled down and no chance is allowed for deposits to collect and become baked to the cylinder walls. The heat in the cylinder and piston is also sufficient to evaporate all the oil from the gudgeon pin, if not carried away quickly; as a result, the pin is left in a perfectly dry state and, if not well lubricated before the next start, will cause trouble.

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[1] Not reproduced.

Lubrication

Due to the high pressures and heavy construction of the Diesel engine the question of lubrication is one requiring more attention than in ordinary gas or steam engines. Some system of positive lubrication is invariably adopted. The question of cylinder lubrication and compressor lubrication is the most serious one to be dealt with. Cylinder lubrication is generally done by having several radial holes near the bottom of the liner through which lubricating oil is forced. These holes are of necessity very small and require regular attention to prevent them from becoming clogged with carbon particles. The necessity for a positive system of lubrication is apparent, and the following article from *The Engineer*, January 3, 1913, is quoted:

> The engine was of 236 h.p., running at 180 r.p.m. The accident occurred by reason of the seizure of the piston in the cylinder nearest the fly wheel, the resulting stresses causing the breakdown. Our contemporary states that the Diesel engine has many risks peculiar to itself, in addition to those common to the ordinary gas engine. The danger of piston seizing in the cylinder seems to be an ever present one, owing to the fact that the cylinder temperatures are very high, and the clearance must be very small in order to attain the compression necessary. The correct sizes can only be obtained by the costly method of trial and error, but in view of the increased price which will undoubtedly be asked in the near future for oil of all kinds (this in England) the maker of the Diesel engine must make every effort to enhance its reliability.

Air Compressor Lubrication

Lubricating oil must be used very sparingly in the compressor cylinders. If large amounts of oil are used, it finds its way into the storage bottles; if the compressor is then allowed to work too rapidly, the temperature of the compressed air is raised to such a degree that there is danger of explosion of air line or bottles. Serious corrosive action in the pipes and cooling coils of air compressors led to investigations that showed that some oils under high pressure permitted acids to form. The acid had a corrosive action and the oil particles a wearing action on the interior of these pipes which caused them to wear thin very rapidly. Lubricating oils for Diesel engines must not only satisfy the conditions existing in the air compressor but must satisfy those of the engine itself. A suitable oil should satisfy the following conditions:

a. The oil is exposed to heat from the piston and cylinders and must not be injured thereby, nor must its viscosity be too much reduced; also, it must not give off gases.

b. Oil should be suitable for using over and over again many times without unduly losing its lubricating properites.

c. The oil should be capable of being cleaned by filtration and decantation. Oils vary greatly in this quality—with some it is exceedingly difficult to separate out impurities.

Starting

The method almost universally adopted for starting Diesel engines of large size is by compressed air. There are two general ways of starting: in one, air is admitted to the cylinders through a starting valve; and in the other, the scavenging air pump is used. By this latter method the main cylinders are never exposed to such extreme temperatures. The reliability of this method of starting cannot be questioned when the engine is in perfect condition. The starting air is contained in storage bottles, and the number of starts that can be obtained from one bottle is no indication of the reliability of the system. In practice the loss of starting air invariably results from the failure of some valve to function, and is almost instantaneous. All Diesel engines installed as individual units should have some auxiliary device for compressing air. Central station units, where two or more engines are installed, do not require this auxiliary apparatus as the possibility of a total loss of air is much reduced.

COMPARISON OF FOUR-STROKE AND TWO-STROKE DIESEL ENGINES

Advantages of the 4-Stroke Cycle over the 2-Stroke Cycle

Lower fuel consumption per b.h.p., the fuel consumption of the 2-stroke engine being from 7 to 10 per cent greater than the 4-stroke. Lower temperatures in cylinders, and lower quantity of heat to be transmitted through cylinder walls. The mean cylinder temperature for the four cycle varies from 850 to 950° F., while in the two cycle it is from 1100 to 1200° F., although in both cases the maximum temperatures are as high as 2000 to 2500° F. The 4-stroke engine requires no scavenging air pump. Lubricating facilities are better.

Advantages of the 2-Stroke Cycle over the 4-Stroke Cycle

Higher power per same cylinder dimensions and weight. For engines of the same size, the power of the 2-stroke engine is from 1.7 to 1.8 times that of the 4-stroke engine. There are less troublesome valves. Less space required for the same power. Permits the use of low pressure and scavenging pump for starting, thus cold air is never admitted to the main cylinders. Costs less for same power.

The 2-cycle engine is finding its principal use in the development of the high power Diesel, where the question of dealing with the exhaust in the 4-stroke cycle engine involves the multiplicity of valves or auxiliary exhaust ports and the weight and size is prohibitive.

APPLICATION AND USE OF THE DIESEL ENGINE

The Diesel engine is now used in almost all places where the steam engine or turbine could be used. The starting torque is poor and it operates best at constant speed. It will not carry excessive overloads, the limit being from 8 to 15 per cent. There are less than 100,000 horse-power units in Diesel engines operating in the United States today.

The American power producers have been slow to demand this engine, probably for the following reasons:

1. The availability of cheap fuel has prevented a demand for an expensive first cost prime mover that will give decreased operating cost.
2. American manufacturers have been slow to take up the manufacture and development of this engine.
3. Engines giving satisfactory service have been in operation in Europe only within the last five years.
4. The engine requires careful supervision when being operated.
5. Some prejudice exists against all forms of internal combustion engines.
6. Oil must be used as fuel, and the cost varies within wide limits.
7. The manufacture of the Diesel engine is attended with difficulties and requires exceptional skill in foundry and machine work.

THE DIESEL ENGINE COMPARED WITH THE RECIPROCATING STEAM ENGINE, AND WITH THE STEAM TURBINE

With reference to the reciprocating steam engine, the following is quoted from the *Proceedings of the Americam Institute of Electrical Engineers*, June, 1914:

The Reciprocating Steam Engine has, during the past five years become practically obsolete for use in modern power stations. In the large new central stations this engine is not even considered; but in small isolated stations it is still used to considerable extent, especially where heating service is also handled. In small sizes, the engine still has some advantage in economy over the small turbine, but the margin is getting continually smaller; some of the latest geared units being almost on equal terms. The non-condensing and bleeder turbines have offered a satisfactory substitute for the engine on heating surface; the continuance of the engine in use is therefore chiefly due to the apparent inability of purchasers for isolated plants to realize that economy of steam is only one of the items constituting cost of power. The superior reliability, low maintenance, sustained original economy, and low attendance cost of the turbine generally overbalance the rather doubtful advantage in original economy of the small reciprocating engine.

The same reference states that "The steam turbine is now at the head of the list of prime movers."

Mr. Adams, in his article on "The Diesel Engine" in the November number of the *Journal of the American Society of Mechanical Engineers*, states that, "The Diesel engine is now being used in almost all places where the steam engine or turbine might be used."

In a small power plant such as the one here at Fort Monroe, and similar plants throughout the service, where buildings are heated by steam from the power plant, the reciprocating steam engine may still have a place. However, it is an open question and one that will bear consideration and investigation. In large power plants the steam turbine has largely supplanted the reciprocating engine, and now the question arises: is the Diesel engine going to supplant the steam turbine? So far as the army is concerned, we are not greatly interested in the large plant, but we are interested in the small plant where 50 to 75 h.p. engines are used, and also in isolated plants where but a single engine of this type is installed. The smallest Diesel engine manufactured in this country is one of 65 b.h.p., and there are no Diesel power plants as small as those that we are interested in, so it is impossible to make an accurate comparison between our steam plants and Diesel plants of the same size. However with data collected from various sources, we shall endeavor to compare the Diesel engine with the steam prime movers, under the following heads:

Economy.
First cost.
Up-keep.

In preparing this heat balance for the Diesel engine, the mechanical efficiency of 77 per cent was assumed and the thermal efficiency of an actual engine, as shown by test, was used as a basis for the remainder. The distribution of waste heat between exhaust and cooling water for this engine varies, so that an equal distribution was assumed.

The heat balance of the turbine plant is a composite heat balance based upon an oil-fired boiler and a turbine generator unit, using the best steam figure that I have record of; 95 per cent is allowed for the efficiency of the generator and 95 per cent for the mechanical efficiency of the turbine.

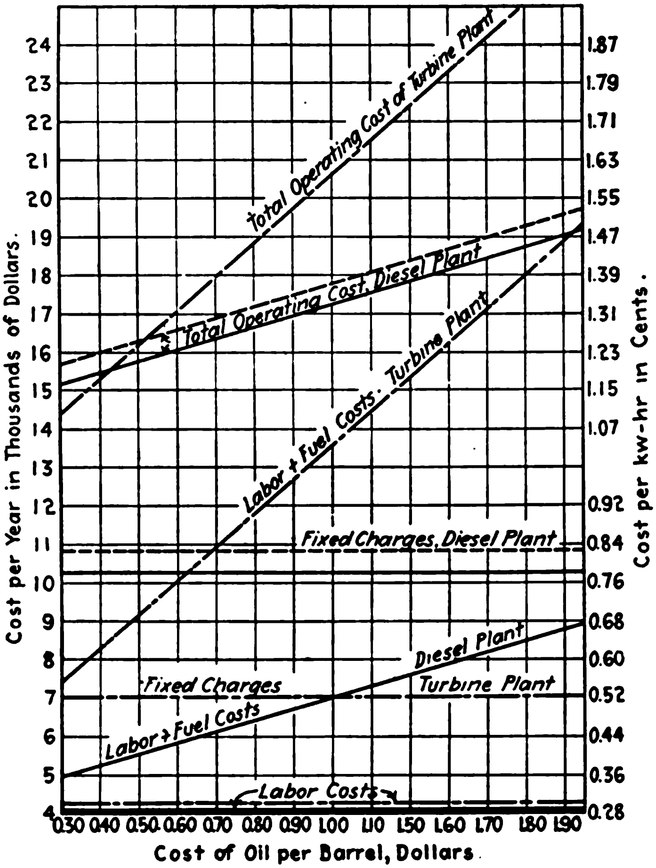

FIG. 3.

1887

The author's idea in making this comparison is to show the best thermal efficiency in both types of prime movers, thus indicating the superiority of the Diesel engine as far as thermal efficiency is concerned. So far as is known, however, no steam turbine plant is operating today with an overall thermal efficiency quite as high as the 20 per cent shown.

The efficiency of the Diesel engine may be still further increased by utilizing the heat in the exhaust for making steam to run a steam turbine. Experiments are now being carried out in this direction, but the results are not yet good enough to indicate that this can be done in all cases. Experiments are also being made along the line of increasing the temperature of the jacket water, so that this may be converted into steam which may be used.

The cost curves (Fig. 3), also taken from Mr. Adams' article, show the yearly cost of plants against the price of oil per barrel. This shows graphically the effect of the price of oil on the total operating cost. By projecting from the total operating cost curve of the steam turbine plant to the corresponding curve of the Diesel plant, a comparison may be secured for any price of oil. On account of the lack of data relative to the life of the Diesel engine, the same fixed charges, namely, 6 per cent depreciation, 6 per cent interest, and 2 per cent insurance and taxes, have been assumed alike for both plants for comparison.

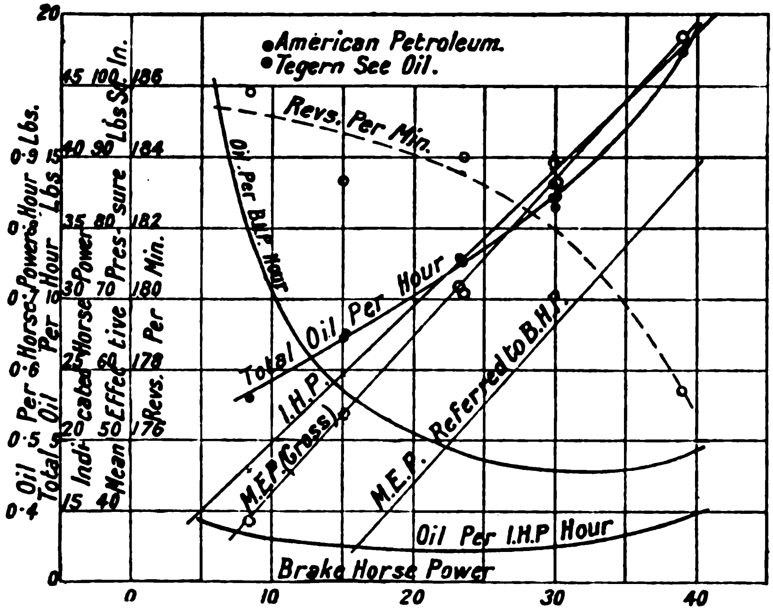

FIG. 4.

The article[1] on the preceding page, taken from the *Electrical World*, will give some idea as to what the Diesel engine is actually doing in this country.

The following nine sets of curves (Figs. 4-12), resulting from tests on nine Diesel engines, made by R. Boyds, M. Sc., and J. W. Campbell, M. Sc., and published in *The Engineer* of April 11, 1913, give some excellent data on the fuel consumption of Diesel engines, and of the most economical loads at which to run Diesel engines of various types and sizes. In each figure is shown the oil consumption per indicated horsepower hour and per b.h.p. hr., all plotted on a brake horsepower base, and it is seen that in general these curves show minimum values at some point below maximum load.

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[1] Not reproduced.

The results shown in Figs. 13 and 14 indicate that the higher the power of an engine the lower is the oil consumption per b.h.p. hr., even after allowing for any differences in the calorific values of the various oils.

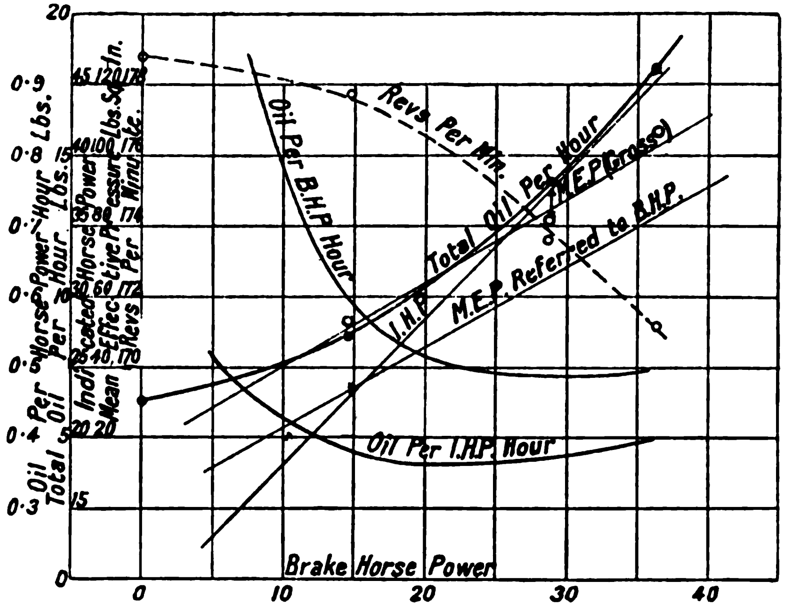

FIG. 5.

The experiments represented in Figs. 15 and 16, which follow Figs. 13 and 14, indicate that, between limits, the engine speed has not much influence on the oil consumption, and it might be inferred that the greater economy of the larger engines was not due to the higher piston speeds, but probably due to higher mechanical efficiencies and, perhaps, slightly increased thermal efficiencies due to larger cylinder dimensions.

For full information with reference to these tests shown by the thirteen sets of curves (Figs. 4-16), and of the engines on which the tests were made, see the above reference from *The Engineer*, which is hereto appended and marked Appendix *C.*[1]

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[1] Not reproduced.

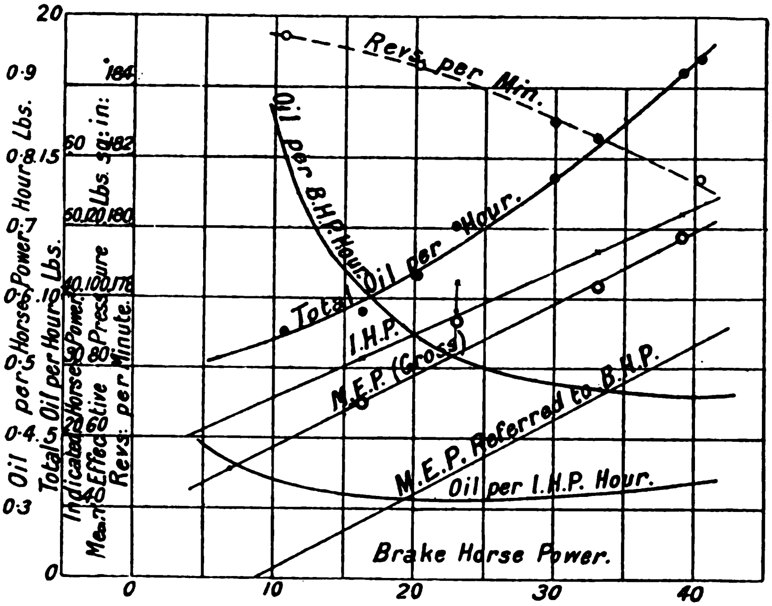

Fig. 6.

1890

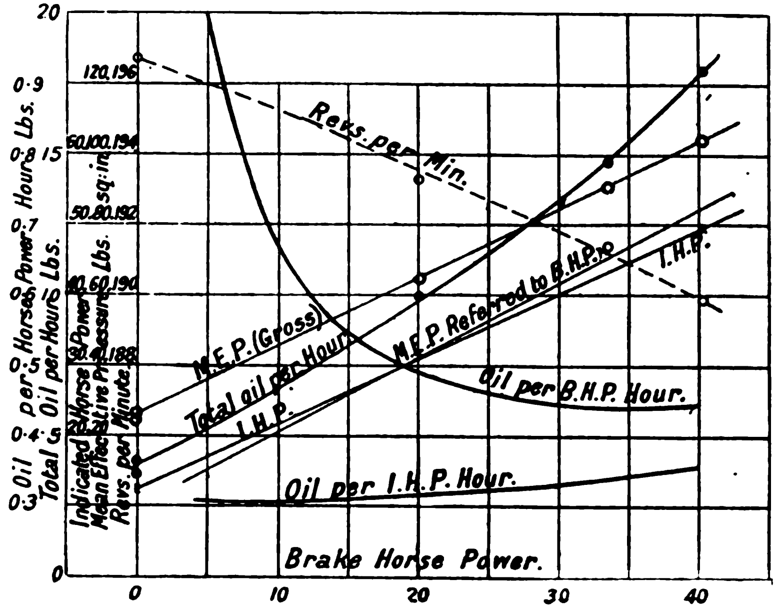

Fig. 7.

1891

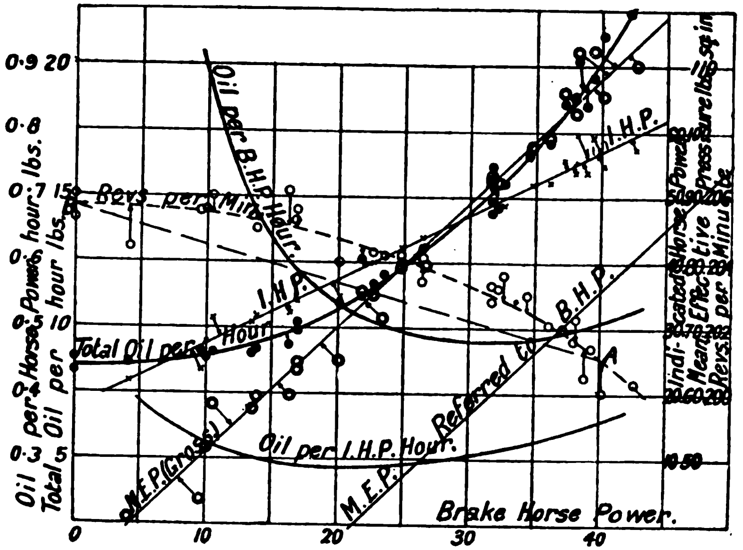

Fig. 8.

1892

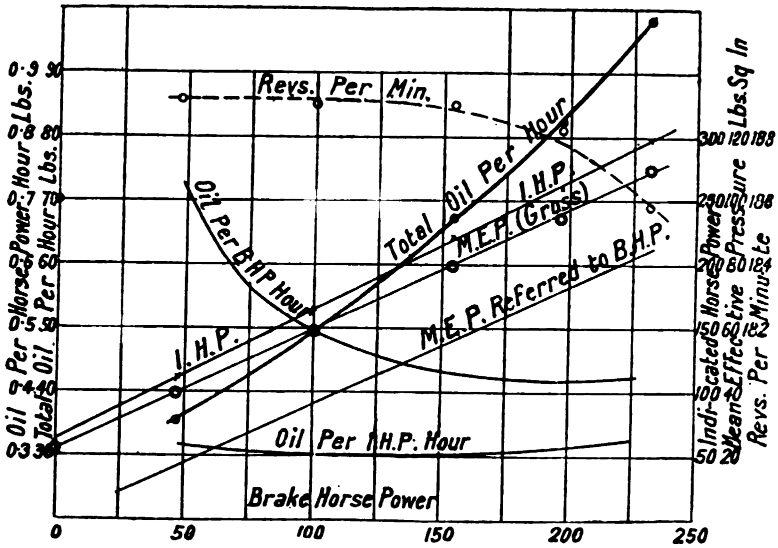

Fig. 9.

1893

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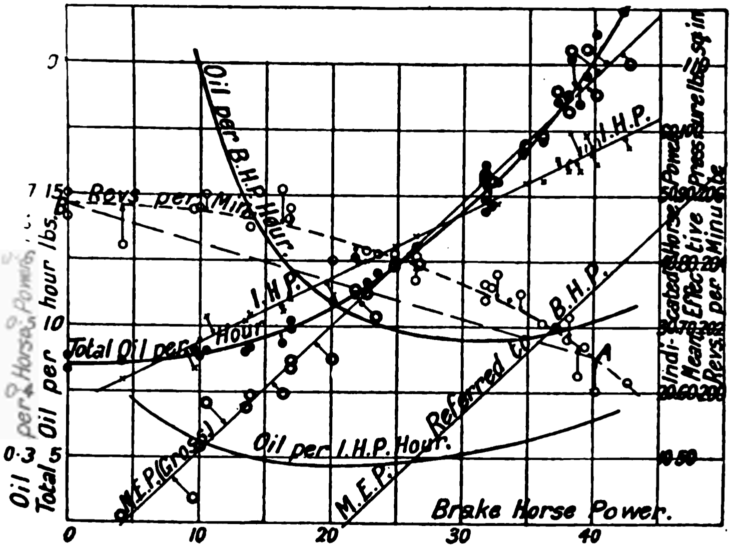


FIG. 8.

1892

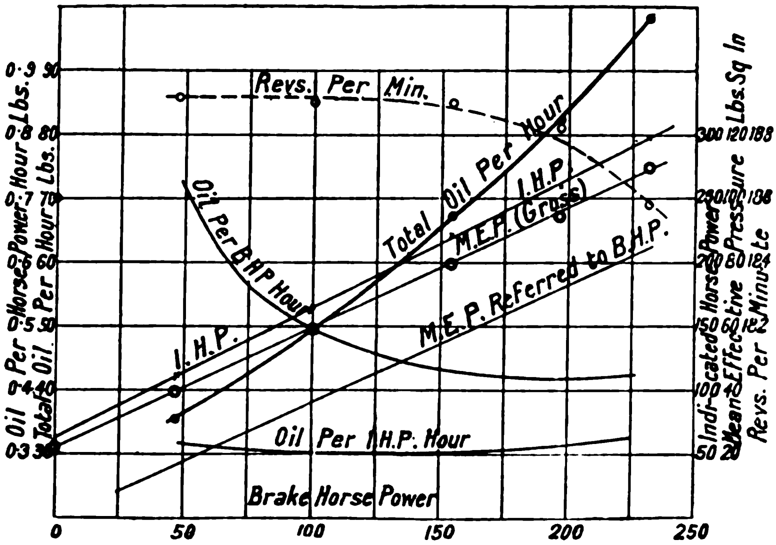


FIG. 9.

1893

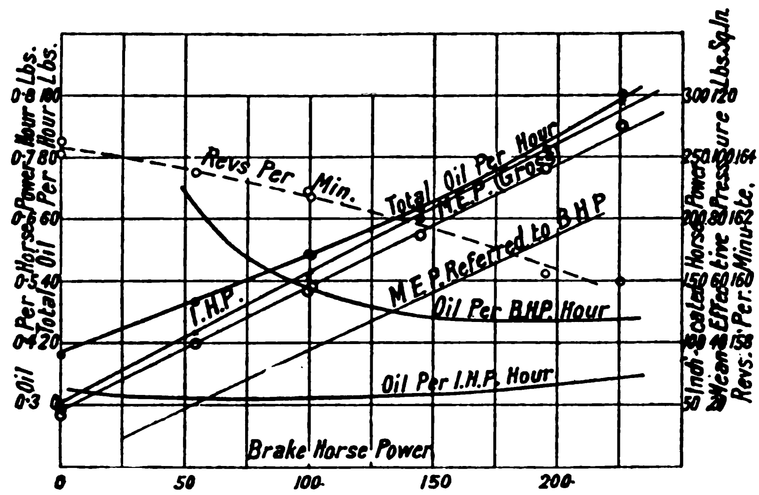

Oil Per Horse Power Hour Lbs.
Total Oil Per Hour Lbs.
0·8 100
0·7 80
0·6 60
0·5 40
0·4 20
0·3 0
Indicated Horse Power
Mean Effective Pressure Lbs. Sq. In.
Revs. Per. Minute.
300 120
250 100 164
200 80 162
150 60 160
100 40 158
50
Revs Per Min.
Total Oil Per Hour
M.E.P. (Gross)
M.E.P. Referred to B.H.P.
I.H.P.
Oil Per BHP Hour
Oil Per I.H.P. Hour
Brake Horse Power
0
50
100
150
200

FIG. 10.

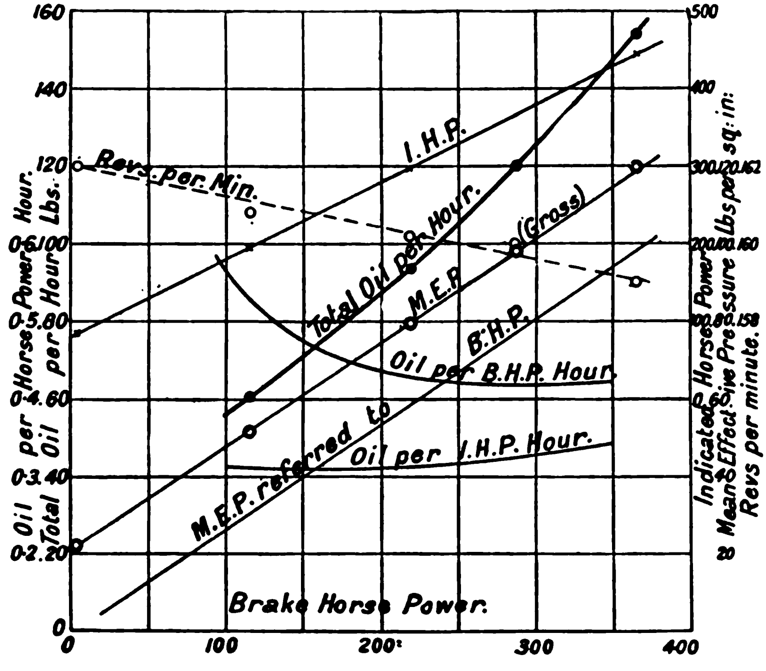

160
140
120
0·6 100
0·5 80
0·4 60
0·3 40
0·2 20
0
Oil per Horse Power Hour.
Total Oil per Hour Lbs.
500
400
300 120 162
200 100 160
100 80 158
0 60
40
20
Indicated Horse Power
Mean Effective Pressure Lbs per sq: in:
Revs per minute.
Revs. Per Min.
I.H.P.
Total Oil per Hour.
(Gross)
M.E.P.
B.H.P.
Oil per B.H.P. Hour
M.E.P. referred to
Oil per I.H.P. Hour.
Brake Horse Power.
0
100
200
300
400

FIG. 11.

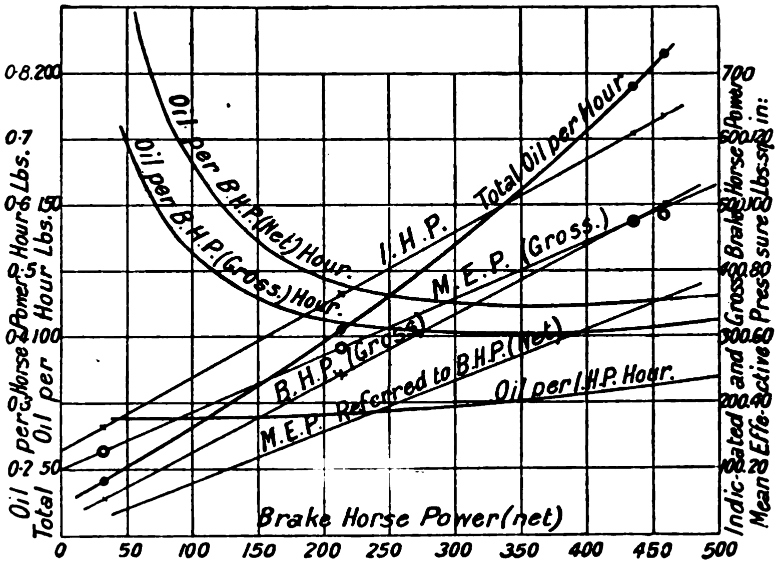


FIG. 12.

1996

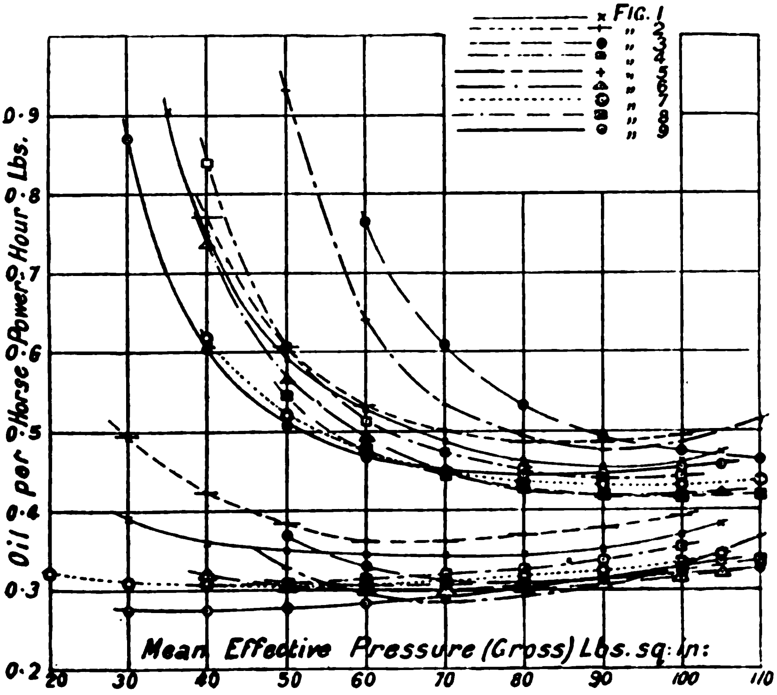


FIG. 13.

1997

TABLE 1. COMPARISON COSTS, STEAM TURBINE AND DIESEL ENGINE, 600 KW. MUNICIPAL POWER PLANT

ASSUMPTIONS

Load Factor = 25 per cent. Maximum load = rated output.
(This gives turbines slight advantage in overload capacity.)
Turbines operated condensing, using jet condenser and cooling tower.
Oil Fuel.
Crude oil, 95 cents bbl. Distilled oil, $1.50 bbl.
Turbine Plant develops 140 kw-hr. per bbl.
Diesel Plant develops 447 kw-hr. per bbl.

FIRST COST

Turbine Plant		Diesel Engine Plant			
1-200 kw., 1-400 kw. Units		3-200 kw. Units		1-200 kw., 1-400 kw. Units	
Boilers & Settings	$ 6,200	Engines	$51,000	Engines	$47,500
Pumps	250	Erecting	5,000	Erecting	5,000
Piping	500	Piping	1,400	Piping	1,400
Stack and Flues	2,950	Oil tanks	1,000	Oil tanks	1,000
Heaters	500	Water Cooling Apparatus	1,000	Water Cooling Apparatus	1,000
Turbines	12,500				
Generators, etc.	11,400	Generators	11,400	Generators	11,400
Condensers	2,400	Building	6,000	Building	6,000
Cooling tower	3,500				
Building	10,000				
Total	$50,200	Total	$76,800	Total	$73,300

OPERATING COSTS, 1,314,000 kw.hr. per Year

Turbine Plant		Diesel Engine Plant				
Wages	$3,000	Wages	$3,000			
Lubrication	500	Lubrication	500			
Miscellaneous	100	Miscellaneous	100			
Maintenance	400	Maintenance	400			
Water	250	Water	50			
	$4,250		$4,050			
			3 Engines		2 Engines	
			Fuel		Fuel	
			95c bbl.	$1.50bbl.	95c bbl.	$1.50bbl.
		Fuel	$2,790	$4,410	$2,790	$4,410
Fuel at 95 cents per bbl.	$8,910					
Fixed charges 14 per cent.	7,030	Fixed Charges 14 per cent.	10,780	10,780	10,280	10,280
Total	$20,190	Total	$17,620	$19,240	$17,120	$18,740

DISCUSSION OF THESE VALUES

Difference in first costs = $73,300 − $50,200 = $23,100.
Diesel Engine Plant costs 46 per cent more.
Difference in operating costs.
(*a*) $20,190 − $17,120 = $3,070. Net saving per year = $3,070.
(*b*) $20,190 − $18,740 = $1,450. Net saving per year = $1,450.

Conclusion: Difference in yearly cost is so small that no definite conclusion can be drawn.

Each plant should be investigated carefully before the type of equipment is decided upon.

As the yearly load factor is increased, the Diesel engine will show a saving in total operating cost due to the saving in fuel. In the steam plant the fuel item is the largest single item of expense, with the fixed charges next. In the Diesel plant the fixed charges are the largest single item, with the remainder of the operating cost about equally divided between fuel and labor, water, etc.

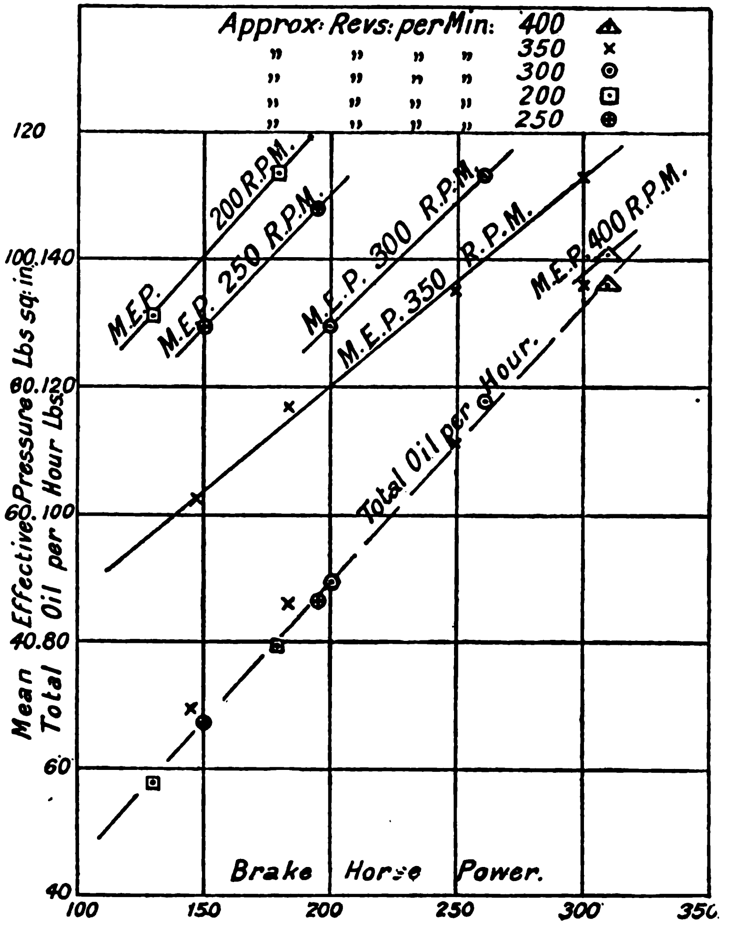


FIG. 15.

The items under first cost of the two plants are only approximately correct, as the author had no personal data available and had to depend upon published results which did not check with one another. The output per barrel of oil is based upon published yearly reports of both Diesel and steam plants. The steam plant is located in California while the Diesel plant is in Texas. The distilled oil cost was purposely placed high, so as to indicate the showing that a Diesel engine could make in competition with a steam plant, even if it was handicapped with a high price of suitable oil. As we are not interested in comparison of coal and oil as fuels, no

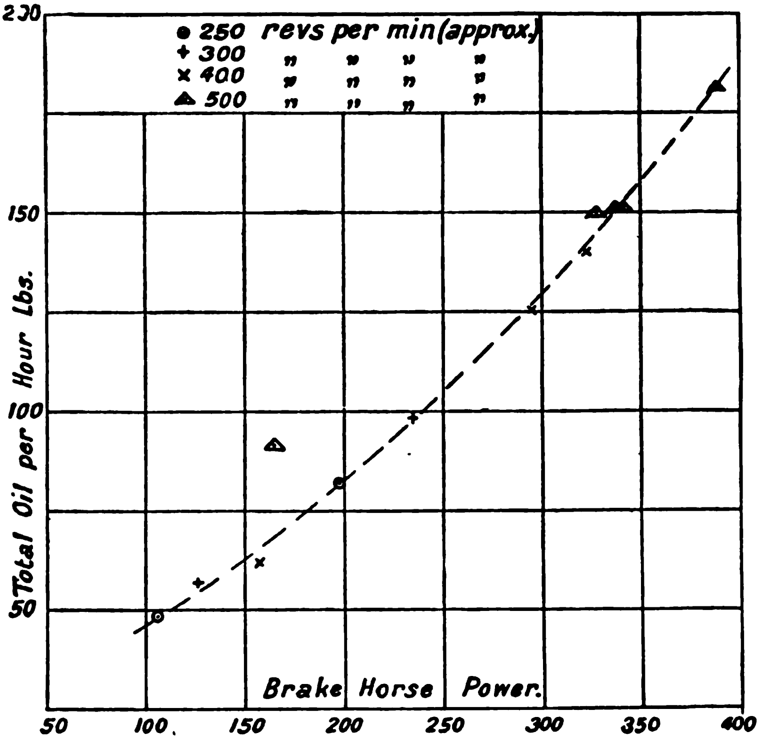

● 250 revs per min (approx.)
+ 300 " " " "
× 400 " " " "
▲ 500 " " " "
Total Oil per Hour Lbs.
200
150
100
50
Brake Horse Power.
50
100
150
200
250
300
350
400

FIG. 16.

1900

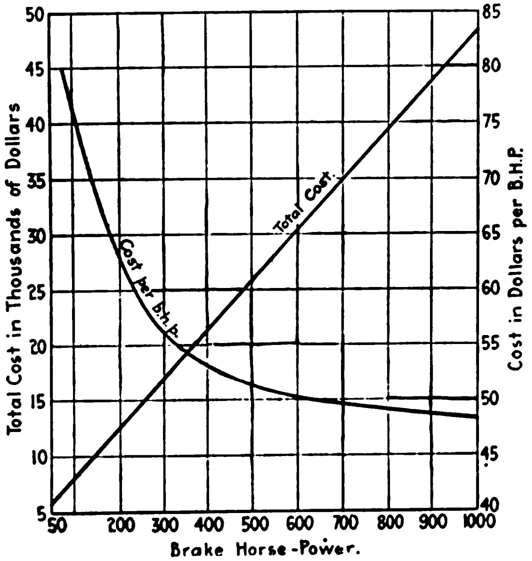

Total Cost in Thousands of Dollars
50
45
40
35
30
25
20
15
10
5
Cost in Dollars per B.H.P.
85
80
75
70
65
60
55
50
45
40
Total Cost
Cost per b.h.p.
50
200
300
400
500
600
700
800
900
1000
Brake Horse-Power.

FIG. 17.

1901

minal simplicity of the turbine is often dwelt upon, but the ugly side their use revealed by these figures is, as a rule, only seen by insurance mpanies who have to meet the bills for repairs. Latterly the Diesel en- ne has come very much to the front, and for many purposes has doubtless great future, but its practical working is at present attended with serious sk of breakdowns, the number which occurs, compared with steam en- ines, being three times as great, while the cost of these is 3.75 times.

No doubt the inherently structural difficulties associated with the steam turbine, the Diesel engine, and the large gas engine will in process of time be surmounted, but this process is not accelerated by the refusal of makers to look the difficulties fully in the face.

Advantages of the Diesel Engine

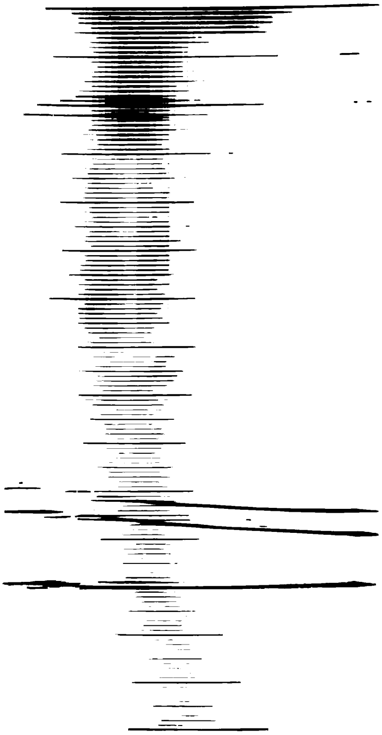
1. Can be quickly started and does not use fuel except when actually furnishing power.
2. Always ready for use and can be started at a moments notice.
3. Higher thermal efficiency than any other prime mover.
4. Greater economy (neglecting the life of the engine, and the up-keep after long years of use; the life of the engine not being sufficient in this country, to obtain accurate data on these points).
5. Less cost for labor in operating.
6. Simpler installation.
7. Smaller building and less room required.

Disadvantages of the Diesel Engine

1. Higher first cost.
2. More intricate mechanism and easier to be put out of order.
3. Requires higher trained operators.
4. Life unknown.
5. The engine is still undeveloped by the manufacturers of this country, necessity not forcing them to start its production.
6. More difficult of lubrication.
7. More difficult to manufacture.

COMPARISON WITH OTHER FORMS OF INTERNAL COMBUSTION ENGINES

Due to the fact that there are in different localities of this country cheap fuel in the form of gas or cheap coal, gas engines have been to developed to a greater extent than have the oil engines. At the present time the following types of internal



The gas engines are designed to operate on illuminating, blast furnace, or producer gas, depending upon whether they are located in a coke, natural gas, blast furnace, or low grade coal district. These engines are built in large sizes, of 6000 h.p. per engine, and are an efficient type of prime mover, where local fuel conditions favor this type of engine.

The only type of gas engine which could be used to advantage for combined post power and fortification plants is the producer gas engine and, for post power plants at most places in the service, it is doubtful whether this type of prime mover has any advantage over the small steam plant. Figs. 6 to 13[1] taken from the June, 1914, number of the *Proceedings of the American Institute of Electrical Engineers*, give the relative cost and efficiency data on gas and Diesel engines. This is taken from American practice.

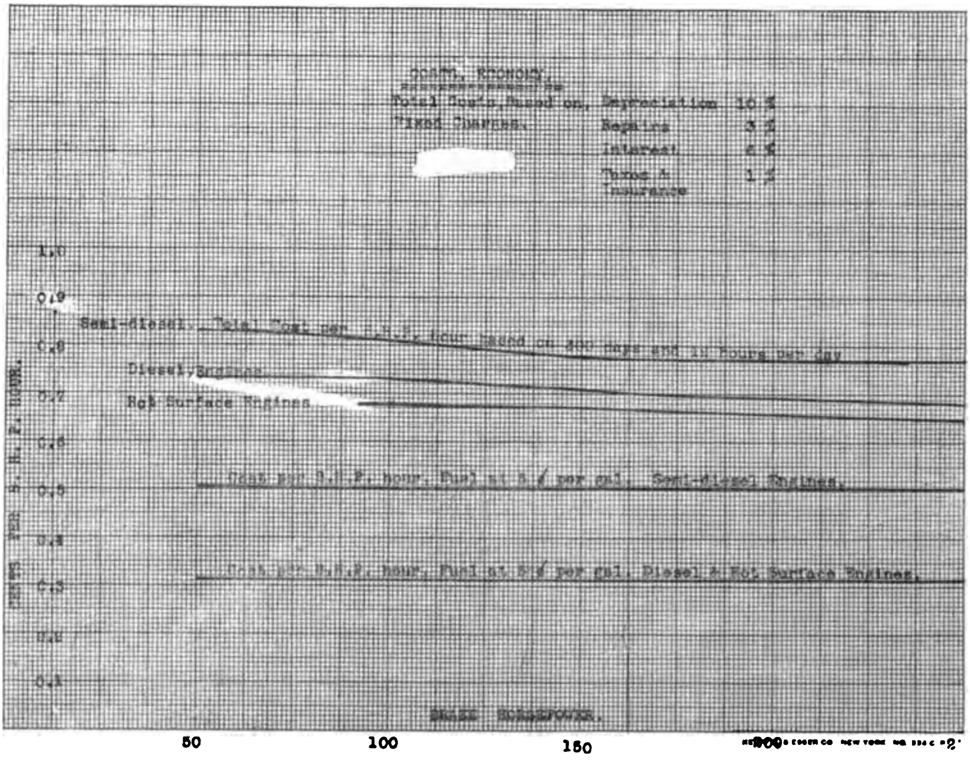


FIG. 19.

The hot surface engines are a development of the early

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[1] Not reproduced.

The fuel economy of the gas engine is very close to that of the Diesel engine, and the first cost is considerably lower. American practice would indicate that this type of prime mover has an economic advantage over the Diesel engine.

Fig. 19 shows the relative cost of power produced by the Semi-Diesel, the hot-surface high economy, and the Diesel engine under the conditions set forth. The Diesel and hot surface-high economy engines are not at present manufactured in sizes suitable for fortification work, but could be considered, for combined Quartermaster and Fortification Plants.

For purposes of comparison of the gasoline engine and the Diesel engine, the experimental data available on the 25 K.W. General Electrical Set and the results of the test of the Diesel Set conducted by the writers, will be used.

The cost of operation is taken as the basis of economy. Fig. 20 shows the relation of oil cost and also the total cost of fuel and lubricating oil. The cost of gasoline is taken at ten cents per gallon. The present[1] cost of gasoline to the Quartermaster Department is slightly below this value, but it is more than likely that the cost of gasoline will be higher in the future.

The cost of fuel oil is taken at five cents per gallon. This price will vary in different parts of the country, but it may be taken as an average.

The cost of lubricating oil is taken at forty cents per gallon. This is an average cost when purchased in large quantities. With the above values of oils, the total cost per b.h.p. hr. for the gasoline engine is approximately four times that of the Diesel engine.

First Cost

The first cost of the Diesel engine, complete with generator and installed, is $4625. The first cost of the 25 K.W. General Electric Set, with fuel tank complete, is $3290.

Up-Keep

Very little data is available on the up-keep of Diesel engines, but it seems to be the commercial practice to allow an average of about 3 per cent for all internal combustion engines. No data is available on the up-keep of the 25 K.W. General Electric Set.

If we allow 10 per cent for depreciation, 6 per cent for

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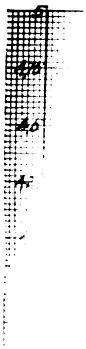
[1] June, 1916.

oil engin
and the



ne as used in fortification work, but over other types of ngines the advantages are not so marked.

The principal advantages are:

1. High thermal efficiency.
2. Wide variety of cheap fuel.
3. Easily and quickly started. This may be important cold weather.
4. In the case of gasoline sets, no electric ignition to get t of order. No timing device to regulate.
5. Commercial practice has demonstrated that the crude il engines are reliable in long continuous runs. This may not e true of the gasoline engine.
6. Crude oil is safer to store and the losses are not so great as in the case of more volatile fuel.
7. No stand-by losses as in the case of a producer gas plant.

DISADVANTAGES OF THE DIESEL ENGINE COMPARED WITH OTHER INTERNAL COMBUSTION ENGINES

1. The first cost is higher per b.h.p. than any other form of prime mover.
2. American design of the Diesel engine has not advanced beyond the experimental stage.
3. As compared with the gasoline engine now in use.
   - a. Requires a higher grade of mechanic to operate the Diesel engine.
   - b. Necessity of repairs being made by the makers.
   - c. Compressed air must be on hand at all times. In case of loss of this compressed air some means must be used to obtain a supply of air, or carbon dioxide gas, at a pressure of about 285 pounds to the square inch, in order to start the engine.
   - d. Danger of accidents, due to high pressure being developed in the cylinder from leakage of fuel.
   - e. Requires a heavy foundation, and the experimental engines require more floor space and more head room than the gasoline set in use.

DESCRIPTION OF THE DIESEL 25 K.W. SET

The Diesel set under discussion was examined and operated in several trials, and has functioned perfectly in every way during these trials. (See Figs. 22 and 23.)

Explanation of Fig. 22

200. Crank shaft.
201. Bed plate.
202. Frame.
203. Working cylinder.
204. Working piston.
205. Working piston ring.
206. Working cylinder cover.
207. Connecting rod.
208. Lower half of bottom end bearing.
209. Upper half of bottom end bearing.
210. Bolt of bottom end bearing.
211. Upper half of top end bearing.
212. Lower half of top end bearing.
213. Bolt for top end bearing.
214. Link to connecting rod from air pump lever.
215. Lever for air pump.
216. Connecting rod to air pump.
217. Gudgeon pin in working piston.
218. Pin in connecting rod for connecting link.
219. Pin in air pump lever.
220. Air compressor lever gudgeon.
221. Pin in air pump lever on compressor end.
222. Gudgeon pin in air pump piston.
223. Fixing ring of air pump cylinder.
224. Air pump cylinder.
225. Air pump piston.
226. Piston ring for low pressure air pump piston.
227. Piston ring for high pressure air pump piston.
228. High pressure liner.
229. Water cooling jacket.
230. High pressure air pump cylinder cover.
231. Air inlet at fuel oil valve.
232. Safety valve on the injection air pipe.
233. Starting valve.
234. Starting valve box.
235. Starting air valve lever.
236. Starting lever handle.
237. Fuel valve lever.
238. Air valve lever.
239. Exhaust valve lever.
240. Fuel inlet cock.
241. Glass bell on fuel pump.
242. Suction pipe for high pressure air pump.
243. Safety valve for low pressure air pump.
244. Horizontal cam shaft.

Fig. 7. The fuel oil pump.
Fig. 13. The fuel oil valve.
Fig. 17. The suction valve of the low pressure air pump.
Fig. 18. The delivery valve of the low pressure air pump.
Fig. 19. The suction valve of the high pressure air pump.
Fig. 20. The delivery valve of the high pressure air pump.

ns of an eccentric attached to a sleeve. The plunger acts trip the suction valve of the fuel pump and thus controls amount of oil pumped to the engine for the different loads.

A plunger pump driven by the main shaft is provided to pply the cooling water to the engine but, in the present case, ty pressure supplies the cooling water and no provision is ade to use the circulating water over again, so the pump is ot being used.

The fuel oil after leaving the pump is distributed to the cylinders through a distributing plate with non-return valves. The fuel passes on to the fuel oil valves which are of special design, manufactured under the Hesselman patents.

Here the fuel is forced into the engine under air pressure of 800 to 1000 pounds.

The length of time and opening of this valve is regulated by a bell crank and a cam on the horizontal cam shaft. The air and exhaust valves are operated by means of bell cranks and cams on the same cam shaft.

Pressure pumps provide for the lubrication of the engine and air pump pistons, and the remainder of the bearing surfaces are lubricated by means of gravity sight-feed oil cups.

The air pump is of the two stage type and pumps the air normally into a small equalizing flask, but may pump direct to the engine when the regulation of the air valve is properly adjusted. Three air flasks are provided, all fitted with pressure gauges. The small flask is used for normal running. One of the large flasks is used for starting and the other as reserve. Air pressure above 285 pounds (20 kg.cm.) must be maintained at all times for starting the engine.

The dynamo is a 125 volt, 200 ampere, interpole D.C. machine, of standard type manufactured by the General Electric Company, and is direct connected to the engine.

Fig. 22 and nomenclature of parts is taken largely from the instruction pamphlet issued by the manufacturers in this country and give further details of the engine and its working parts.

USE OF THE DIESEL ENGINE IN THE COAST ARTILLERY

After our brief investigation of the Diesel engine, we are not in position to make definite recommendation as to this prime mover. We have considered a collection of data from the American and English point of view. This represents the best practice from practically all sources available. The writers of this data do not make definite recommendations as to the installation of the Diesel engine as a prime mover, and much less should we attempt to do so. We appreciate that the Diesel engine has no doubt a wonderful future before it; and what we do recommend is, that the service investigate and collect, on the present commercial engines placed on the market by the different manufacturers in this country, data for the type and size of engine most suitable for our uses.

The present state of development of the Diesel engine in the United States does not warrant its adoption for general use in Coast Artillery plants. It may prove upon investigation that in this country some other form of the crude oil engine may prove more suitable for use in the service. The Semi-Diesel, hot surface-high economy, and producer gas engines, have in different cases proven very efficient in American practice.

In the present state of development it would appear that a medium power, four stroke cycle, single acting, vertical type of engine would be most suitable for Coast Artillery plants. As to the make of engine most suitable, nothing can be recommended.

The engine should be installed for experimental purposes in two or more of our post power plants, and two or three could be provided to supplant the present 25 K.W. gasoline sets. The information to be derived from thorough tests of these engines, together with that which could be obtained from commercial practice with the different makes of crude oil engines being manufactured in the United States, would form a basis for determining the size and make of engine most suitable for use in the Coast Artillery service.

MILITARY CHARACTER[1]

A Lecture Delivered by Commander FRANK H. SCHOFIELD, U. S. N.,
to the Officers of the Atlantic Fleet, June, 1913

Strategy and tactics are often regarded as questions of numbers, distances, times, and geographic conditions exclusively. The geometric aspects of these subjects are not comprehensive aspects. There is a spiritual side to strategy, a spiritual side to tactics, a spiritual side to every act of war. It is there that character finds expression. In recent years nations have recognized with increased clearness and force not only that the spirit, morale, and character of their military forces are of supreme importance, but also that the quality of these is not accidental but results largely from controlable conditions.

It seems appropriate now to bring to service attention the very great importance attaching to the character of the personnel of the service and especially the importance attaching to the character of the officers of the service. It is, or ought to be, the ambition of every officer to perfect the kind of character in himself most suitable to his honorable profession. Every one of us has a desire more or less subconscious for just this kind of personal development but very few of us have taken systematic steps towards the attainment of such a character as we esteem desirable.

This paper was prepared in the hope that it might help officers in the systematic development of some of those traits of character appropriate to the military profession.

The motive here is distinctly utilitarian. Most examinations of character are made from ethical or from the moral standpoint. Such examinations of character are referred to the standards set by religious precepts or by the dictates of a

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[1] This paper makes no claim to originality of subject matter. There is no novelty treated here. Foster's *Essay on Decision of Character*, Royce's *The Philosophy of Loyalty*, Clausewitz's *The Genius for Command*, as well as the works of Henderson, Wilkenson, Mahan, Corbett, Von Bernhardi, Kraft, Von der Goltz, Dodge, Upton, Daveluy, Darrieus, Roberts, and many others, have been studied as a necessary preliminary to the writing of this paper. Direct quotations are suitably indicated.

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An article in the *Revue de Deux Mondes* of March 1, 1842, described the instruction of Napoleon, the youth. In it the author spoke of Napoleon's omnivorous reading, of his habit of constantly making notes in the shape of quotations from and critical remarks concerning what he read. A large number of these notes are given and then the author says one is struck by the fact that Napoleon like all other great geniuses obeyed that law that nothing great can be accomplished without great effort. In his deep and persistent study, Napoleon as a boy and youth laid the foundation of genius yet to develop, but this did not show how that genius was formed.

In 1886 I read the history of the Italian campaigns of Marshal de Maillebois, 1745 and 1746. It was then that the veil was lifted and I saw the formation of a great military genius. Napoleon had read these campaigns, had been a pupil of Maillebois'. The plan of the Italian campaign of 1796 was borrowed from Marshal de Maillebois. Napoleon's principles of the strategic and the defensive and of the strategically flanking positions have a similar origin.

The plan of Marshal Maillebois guided Napoleon almost exactly until in the Lake Garda region he found himself between two Austrian armies. Nothing in Maillebois' plan told him what to do on this occasion. He faltered, and enquired of Augereau what he would do to save the army. Napoleon was for retreat which meant disaster. Where was his genius—not yet ready to walk alone. The determination, spirit, and ability of Augereau pointed out the solution by the use of interior lines. Napoleon's mind was keen. He grasped the idea and brought the campaign to a successful conclusion. From this time experience and confidence and knowledge increased until the General by growth became the military genius. And this is the point I want to emphasize. The genius of Napoleon was a growth from the genius of others; it was a development. He followed the methods and plans of others until the best of their spirit became his spirit, and until his knowledge and experience enabled him to advance with a firm step into new fields. Is the genius of Napoleon diminished by this revelation?

Nothing is farther from my thought. I have wished only to show that there is no innate genius; that genius is a gradual development like every product of creation; that it does not shine forth except after profound study; and that in its beginnings it is obliged, like every creature that tries to walk, to follow a guide on whom it leans. This law of human effort exists everywhere in all the conceptions of human activity. In examining at Perugia the early pictures by Raphael, who is not struck by the influence that Perugino, his master, had exercised on him? In contemplating St. Peter's at Rome, that chef d'oeuvre of grand and majestic proportions, one is mute with admiration before the genius of Michael Angelo; but if one has first seen the coliseum, and especially the cupola of the Pantheon, which seems suspended in the heavens, it is understood where Michael Angelo found the model from which came his inspirations.

The genius differs from other men in this, that he may soon dispense with his guide and become in his turn a creator, to leap forward in his career, like the eagle which soars confidently forth after his first fluttering attempts. But the true genius never ceases work on that greatest and most wonderful of physical things, the human mind. Always, he is building it up by the untiring effort of a will that has an end in view.

On the 27th of March, 1815, Napoleon wrote to Marshal Dabout, Minister of War, "Prepare for me a memorandum of what has happened

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Side by side with unity of effort stands continuity of effort and this demands decision of character in all leaders. A task abandoned when half completed, a pause in operations through indecision, a plan changed through vacillating intention; all destroy unity of effort, weaken the driving force produced by the accumulated momentum of continuous effort. Decision of character is an essential quality of military character.

Military operations demands more than loyalty, more than decision of character. There is not time for the chief to give everywhere the impulse suitable to the occasion. His subordinates must see and act for themselves in many cases. The forces of mentality and character are the dominating forces in war.

Loyalty is a form of partnership. It requires a continuing consciousness of membership. It is not mere emotion. It is neither negative or passive.

> Whoever is loyal, whatever be his cause, is devoted, is active, controls himself, is in love with his cause, and believes in it.

Loyalty is the central principle of military relationship. Its aim is unity, and unity is a necessity in war. True loyalty is to an end to be attained and not to an individual. "It is the service of a superpersonal cause." Military loyalty is the service of the object of the military organization. The object of so great an organization can not be efficiently attained without a plan, so *loyalty in all subordinate grades means active fidelity to the plan of authority.*

No man can be fully loyal either to a cause or a plan or to the representatives of these without a full understanding of them. The will to be loyal may exist in all completeness, but be ineffective because hemmed in by lack of sufficient knowledge to guide loyal efforts. Loyalty means intelligent activity—the sustained service of an understood cause.

In an army maneuver a captain was directed to take his company to a certain place and remain there. He obeyed. Later a general officer passing that way enquired of the captain what he was doing there and was informed by the captain of his orders "to remain." It was not conceivable to that general officer that the captain had no further instructions, but such was the case. Was that captain loyal? Not unless he had exhausted every means to determine his true relation to the affairs in hand. Loyalty is not characterized by blind and servile obedience but by intelligent, active, and zealous obedience.

Since loyalty involves a partial surrender of individualism, the individual must become convinced that such surrender is proper. To some it may appear that loyalty means unworthy servitude. The Samurai are said to have been models of military loyalty. They placed the service of their cause high above every other consideration and yet no class of men were ever more jealous of their individual dignity and honor. They never lacked self-assertion, nor accepted tyranny, yet their greatest pride and honor was in loyal service. Loyalty is not the lessening of individual worth, but rather its enhancement. It may discourage strident self-assertion but it does not suppress individual judgment and initiative. It directs these. It stimulates a man to be great within his own area, to prepare to be great in a greater area. It is a safe guide to sound conduct.

We find that there is no surer road to the willing and full acceptance of loyalty in its fullest and most comprehensive sense than knowledge and interpreted experience. Historical study focussed on the effects of true loyalty and especially on the effects of its absence convinces one that there can be no other sound system of military conduct than that founded on true loyalty. It you doubt this, read the campaign of Waterloo and sympathizing with Napoleon taste the bitterness of the incomplete loyalty of his lieutenants. There will remain a higher incentive to real loyalty than it is possible to produce by any academic discussion of the term. Increased knowledge, by extending the horizon of the individual beyond his own particular field of action, stimulates him with a desire to make his effort and conduct harmonize with the general plan. Study of the broad questions of our profession automatically creates a loyal intention because the man sees in it the one sure road to the goal. But there is a knowledge, essential to complete loyalty, still more immediate than that included in general education and training. This is the knowledge that authority only can furnish. It is information of the matter in hand. It is the explanation of the immediate plan. You cannot expect an officer to be fully and intelligently loyal who only half understands the intent of the effort he is ordered to make. Give him full information, make him a real partner, but distinctly a junior partner, in the undertaking and you will find a far more efficient support to your intentions than you would find were he obliged to act surrounded by the mystery that from time to time in our service has stifled mutual confidence. Give him the information necessary to guide his loyal intention. On his part, he must seek the information necessary to his loyal activity. He should never be satisfied to act in the dark when light can be had for the asking.

One has but to refer to the oft repeated history of Nelson's pursuit of Napoleon to Egypt to see demonstrated in historical precedent how a remarkable spirit of loyalty can be instilled into a command by making subordinates partners in a great enterprise. Nelson told his captains the state of affairs, his hopes and fears, and further instructed them on many occasions in his plans of action. No victory was ever won in which the subordinate officers were more unanimously intelligently, and fully loyal than the victory of Aboukir.

So soon as the feeling of true partnership in an undertaking is established, loyalty and all its beneficient effects follow as matters of course. The junior takes as much pride in using his genius within his area as does the senior in using his greater genius in the greater area.

Although our loyalty is to the aims of the government, and more immediately to the aims of our service, yet it is intimately associated with the interrelations of individuals. In a military organization, the leaders must represent the aims of the organization. The loyalty of the subordinates must be fortified by the belief in the fullest loyalty of the leaders of those aims. There must be confidence in the ability of leaders, confidence in their devotion, in their true loyalty, or else a friction is introduced that exists so long as there is lack of such confidence. This requires of leaders knowledge of service aims, continued intelligent and convincing effort towards their realization. A flabby performance of duty on the part of any individual has a distinctly destructive effect on the loyalty of his subordinates. If leaders set the true pace, they inspire in subordinates a desire to be equally loyal. "To show in themselves a good example of virtue, honor, patriotism, and subordination" is an injunction pregnant with wisdom.

Brilliant work on the part of the leaders even in peace time maneuvers is a powerful stimulant to the loyal attitude of subordinates. I remember serving under a flag officer for a whole cruise. At first the comments on his conduct of the

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the initial stages of the Russo-Japanese war, General atkin determined to mobilize his army at Liao-yang. eeded time for this operation. He estimated that he l not be strong enough to prevent the Japanese advance the Yalu, but that he could obstruct and delay that ade by making use of the special features of the terrain to ment the resisting power of a small body of troops maneung in retreat. To this end he gave General Zasulich, manding the Yalu forces, orders to "retard the passage of enemy through the Yalu; to determine his forces, dissitions and lines of march; to retreat as slowly as possible the mountains, and to renew there the most obstinate restance that your numbers admit of before you retreat." eneral Zasulich replied to this order by saying, "His Majesty as made me a Knight of the Order of St. John, and I do not etreat." He was unable to make good his utterance regarding retreat, and had to retreat even sooner than he would had he accepted the orders of his chief. His spirit was loyal as loyalty is too often understood, but he did not understand the meaning of true loyalty. He seemed to see his own situation as a war in itself, unrelated to the general scheme. True loyalty requires a grasp of the situation, a continuous understanding of events, that visualizes the future and is thus a guide to the present. True loyalty requires a constant effort to attain the viewpoint of the superior in order that one's own situation may be more fully understood as a part of the whole. One of the supreme tests of character is to decline decisive action when the situation so demands. The individual taking such responsibility knows that he personally will be reviled by the ignorant and untrained, and yet true loyalty makes such demands of its adherents.

In a narrower and more frequent field we find juniors of all grades, subordinate to the Commander-in-Chief, breaking down true loyalty by careless and ill-considered words of criticism. They are thoughtlessly ignorant of the disloyal attitude and its damaging effects. Those who criticise their seniors, set the example for criticism for themselves by all who are subordinate to them. So great an admiral as Jervis said, "I dread not the seamen, it is the indiscreet, licentious conversation of the officers and their presumptious discussions of the orders they receive that produce all our ills." Loyalty in an organization requires a constantly loyal attitude towards all on the part of each.

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his subordinates and colleagues in anxious fluctions through "resolutions adopted, rejected, resumed, suspended." This is not through any lack of loyalty or lack of devotion to his cause, but through the conscious lack of knowledge and ability. He may strive for the best, but, through lack of confidence in himself and in his own judgment, is buffeted by the conflicting opinions of those about him.

Decision of character is the habit of meeting each situation that arises with a prompt, clear, and firm reply as to what shall be done and the way to do it. Notice that decision of character is a habit, and that habits are acquired.

Clear, firm decision is a mental act that requires the recognition of a task, an appreciation of the obstacles in the way of its accomplishment, and a knowledge of the means at hand for overcoming these obstacles. From this data the mind of the decisive man adjusts means to ends by a reasoning process that is both logical and conclusive.

It is, of course, possible to make decisions without reasoning, but a decision that is based on impulse has no stability. The man who reasons out his decisions and weighs the influence of each factor of the situation is not surprised later by unconsidered factors. He applies his brains *in time* and thereby gives stability to his decision. Decision on impulse is the insecure refuge of the indolent.

For example, the day before sailing the chief boatswain's mate reports that the sand locker is empty. The executive officer decides to send for sand and has also to decide what boat to send. Without much thought, he sends a message to the officer of the deck to send for sand using the first cutter. A few minutes later he receives a message to the effect that the first cutter is being painted. "All right, send the second cutter." "The second cutter stove a hole in her side yesterday and the carpenter is repairing her." By this time the executive officer stops long enough to actually estimate his little situation, to remember the condition of the ship's boats, their employment and availability, and finally decides with full knowledge, which he had all the time but didn't use, to send the second sailing launch. The impression he has produced on the officer of the deck and incidentally on the messenger boy is one of indecision through indolence.

The same character of illustration serves equally well if it so happens that the decision as to the boat to be employed lies with the officer of the deck. The point is that the decisive mind *thinks* for conclusive effect, and this is not gained by a "series of thoughts and fancies without deductions or dependence in which the conclusion occurs to one." The man who would develop decision of character must follow every line of reasoning to a conclusion, must apply his brains *in time* to every situation presented to him.

But this emphasis of methods of reasoning does not imply that decision of character can be derived from reasoning alone. Every line of reasoning must be based on premises. The truth and completeness of the premises are as important to the conclusion as is the logical use of the premises. The faulty and incorrect conclusion is the forerunner of indecision. The more accurate and complete the knowledge from which the conclusion is deduced, the greater the permanency of the conclusion.

> A thousand familiar instances show the effect of complete knowledge on a decision. A man perfectly acquainted with the intricate paths of a woodland district takes the right one without a moment's hesitation, while a stranger, who has only some vague information, is lost in perplexity.
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> The indispensable necessity of a clear and comprehensive knowledge of the concerns before us is not fully realized until a man is placed in circumstances which force him to act before he has had time or after he has made ineffectual efforts to obtain needful information and understanding.

If he has not the requisite information, he is compelled to fall back on such information as he may have and from it derive his decision. In war it is the habitual condition to be confronted with situations only vaguely outlined. An incident here, a hostile contact there, rumors from everywhere, and the necessity to act, are the data. The man without clear conceptions of war, without an accurate knowledge of principles and their appropriateness, without a background of experience, either borrowed or his own, will feel the torturing doubts of loyalty guided by ignorance. On the other hand, a man who has stored history in his mind with understanding will feel a confidence derived from a certain prophetic quality of vision that makes use of the interpretive value of a background of experience. To him the scattered and unrelated items of information take on a form and meaning warranting and encouraging decision. Knowledge and experience beget understanding, and understanding is the strong right arm of decision and character.

Knowledge is not derived from study alone, but largely from observation: "Extreme vigilence of observation, a strongly exerted power of generalizing on experience" builds up with great rapidity the store from which decision of character may be drawn.

The man of decision of character has a goal in view, an end to be attained. His plan is flexible, his goal remains unchanged.

> The regulation of his plan must greatly depend on the course of events which come in an order not to be foreseen or prevented. But in accommodating the plan of conduct to the course of events the difference between two men may be no less than that in the one instance the man is subservient to the events, and in the other the events are made subservient to the man * * *.

This difference of character is perfectly visible in the normal attitude of men. It is no uncommon thing to hear voluminous and plausible argument why a thing cannot be done. This is the normal approach of the man of indecision of character. He is prolific in the reasons for not acting. On the other hand an expected hindrance, a new obstacle arouses in the mind of a man of decision of character questions as to how to overcome the hindrance, how to remove the obstacles or make it subserve the attainment of the end in view. To revert to terms more closely associated with war college work, we may say that the man of decision of character never contemplates the abandonment of his *true mission*. Loyalty to his plan and to the cause of his commander stimulates his mind to the keenest possible effort with the end in view of doing that which he set out to do. This compels the recognition of every obstacle as a problem to be solved. The application of brains to cases is a stimulant of *decision*. It is doubtful if we realize how often the average man fails to really apply his brains. Many of the might-have-beens would have been, had not a habit of mental indolence prevailed in lieu of keen intellectual effort. One of the most pregnant recorded sayings of Nelson is, "I am not come forth to find difficulties but to remove them."

To cultivate decision of character we must keep the brain working for effect—continually driving toward a conclusion. The habit of considering each situation as a problem, of always remembering there is a *mission*, of always thinking to a conclusion, will build and strenghten decision of character.

There are required in the cultivation of military decision of character:

1. Knowledge of war derived from historical study and interpreted experience.
2. Knowledge of the scheme and aims of the military organization.
3. Knowledge of the matter in hand derived from observation, from reports, and from the known or supposed desire of the chief.
4. Habitual exercise in comprehensive reasoning to a conclusion, as distinguished from random thinking.
5. Habitual effort at definiteness of decision. The endeavor should be to reduce by every possible means the number of decisions that have to be changed.

The man who seeks decision of character should decide knowingly if he can, ignorantly if he must, but in any case he should decide. This must not be construed as urging premature decisions. The foreseen necessity of a decision permits a more careful solution of the problem. The effort should be to foresee and solve in advance every likely situation, but to reserve the decision to its appropriate time.

If anyone is at a loss to know if he has a real basis for decision of character, let him apply this test:

> The man with sound reliance on his own judgment is conscious that objects are presented to his mind distinctly in an arranged order, that in each deliberation the main object keeps its clear pre-eminence while he perceives the bearings which the subordinate and conductive ones have on it.

Among the elements of Grant's greatness which some have chosen to call the *Mystery of Grant* was his ability to see among all the multitudinous events he was associated with, those things which were of most importance, and the further ability to keep his attention principally on the attainment of those great things which he recognized as of deciding importance. They occupied so prominent a place in his mind that matters of lesser importance could not obscure them.

INITIATIVE

Initiative as a quality of military character means energy and aptitude in acting on one's own responsibility. If we say of a man that he has initiative, we mean that he is quick to size up situations and meets them promptly, with suitable energetic action. This quality of character is one of the most valuable qualities a military leader can have whether he be the Commander-in-Chief or one of the great body of subordinate leaders. True initiative in character requires of the individual that his action be *suitable* to the situation, that he have *aptitude* for undertaking new measures. The man whose energetic measures are rash and unsuitable, lacks essential element of aptitude in his initiative.

There is another initiative sometimes confused with initiative of character, this is the right of commencing, originating, or setting on foot. It is this increased freedom from restraint that many officers confuse with initiative of character. They regard this increased freedom of the subordinate as necessary to any marked increase of service efficiency. We cannot agree that independence of the subordinate will prove a panacea.

Efficient co-ordination of effort, unity of action, is the true goal of training in preparation for war and the necessary ideal of all military forces during war. Centuries of experience have demonstrated that unity of action requires a single supreme leader—a commander-in-chief. Since he cannot be everywhere at once, and has not the time or opportunity to decide all the minor situations that arise, he must depend largely on subordinate leaders for the execution of his intention. This requires that these subordinates act promptly in accordance with the ideas of the chief, in accordance with the plan. It is just this phase of effort that constitutes the commanding value of initiative in the character of subordinates—the acting in harmony with the plan, without delay. The man cognizant with the situation, present on the spot with power to act, is the one best man to see and seize the time for acting. If he has not been trained to assume responsibility, he may see the opportunity and not seize it. If he has not been given the power to act, he may see the opportunity and let it slip. If he sees the situation, but is not cognizant of the relation it bears to the general situation, he cannot act wisely except by accident. Initiative of character is not governed by caprice, but governed by principles in harmony with plan and in harmony with the will of authority.

From this we see that a full and efficient use of initiative of character requires that he who exercises it have:

1. Knowledge of war derived from historical study and interpreted experience.
2. Knowledge of the schemes and aims of the military organization.

Jervis ordered Nelson's move supported. Victory followed. The initiative of character that carried Nelson with a single ship from his accustomed station in the column to head off a fleet of hostile vessels, within an hour led him across the decks of an enemy ship to board and capture still another ship of the enemy. Was ever any conduct more highly loyal and zealous than those acts of brilliant initiative?

But the wonderful results of the independent action of Nelson in his subordinate capacity should not be allowed to obscure the fact that even in this case he was ever and above all loyal to the plan of his chief. The last ship of the English column was about to pass clear of the last ship of the Spanish column before Nelson made his famous move. Now the scheme of his commander-in-chief was to engage the Spanish ships that were to the windward before they could effect a junction with the division leeward. The whole British fleet knew that. So Nelson never left his place in the column until he saw that Jervis had no intention of tacking together, but rather in succession. Further Nelson did not make his famous move until he actually saw the enemy start a movement toward the junction of his forces, and last and most important of all, his move did not impose a change of plan upon his chief, but was directed towards the most efficient possible support of the existing plan. Nelson had the knowledge, the loyalty, and the courage to make his brilliant initiative a classical precedent.

Many officers believe that they are condemned to an under-development of initiative of character because they are not given greater freedom in their subordinate duties on board ship. It is undoubtedly true that seniors oftentimes deal with the details of duties that are properly within the province of the subordinate. This is displeasing to the subordinate and injurious to his pride; but is not fatal to his spirit of initiative, if that spirit be genuine. He simply has before him the task of convincing his senior by his performance of duty that his duty will be efficiently performed even though there be no interference. Within the subordinate's own area, no matter how restricted by faulty administrative methods, there is room for a zealous initiative that will bring to him a constantly enlarging area of discretion as he demonstrates his zeal and loyalty. Even in those ships where seniors are more attentive to subordinate jobs than good practice warrants, there are always certain officers exempt from interference.

They are the ones who have proved their competence. The fore-runner of the initiative granted by authority must be the demonstrated competence and loyalty of the men to whom increased powers are given.

I have in mind a ship in which the usual centralized organization was in force. The division officers had the usual duties to perform and did those duties well. But one officer among them desired to establish himself in a position of more direct responsibility for all that concerned his division. He performed all the prescribed duties and in addition started in to build up a division spirit. He heard the troubles of each individual; he gave personal instruction to them; he arranged their sports; he promoted holiday expeditions; he attended mast whenever any of his men were at the mast; he asked on occasions for special favors for special men; and he kept an efficient and orderly division. In a short time he was as much captain of that division as any army captain was ever captain of his company. He built up his own area of discretion and demonstrated his real initiative of character. The same field is open to any officer, no matter what his sphere of action, in whom the spirit of progress is striving for expression.

Subordinate initiative of character should be cultivated in every way. Many of the ways are under the control of the subordinate himself. At the War College we train officers in strategic and tactical initiative. We imagine cases and build up initiative of character by the solution of these problems likely to confront commanding officers and flag officers in war. We endeavor to develop and establish an understanding of the right application of true initiative by study of, and practice with, concrete cases. Any officer, who feels that his present area of discretion is stultifying to his character, has always above him the whole vast field of the greater service problems to which he may apply his restless intelligence and zeal. If he would train well, let him stick to cases and avoid generalities. By such procedure, he will build up in his own character a real initiative; for in thus reaching ahead, he is exercising the very quality he seeks to strengthen in himself. The mere fact that when he has performed these intellectual acts he is unable to apply his decision in action, should be no deterrant to his zeal. The intellectual act is the difficult one, training in that which puts one far ahead.

So long as initiative of character does not break down the cohesion, the co-ordinated effort, the unity of action of the navy, the application of it is sound. But cohesion, co-ordinated effort, unity of action, are fundamental necessities. No theory, no doctrine, no action, can be allowed in contravention of them.

The more intimately subordinate leaders are associated in the accomplishment of a mission, the more necessary it is for them to adhere to the plan, to act, each one within his own area of discretion and to recognize that departure from the expected course will invariably mean a certain delay and friction incident to the disturbing influence of this action on the support of co-operating colleagues. The use of initiative by subordinate leaders is directly and intimately related to the power of maneuver of the whole force. The disentigrating effect of independent action of parts of the force must be constantly weighed in order to decide rightly if such independent action be justified. The officer with zealous initiative should normally seek the field for its exercise within the area of his free authority.

The junior should recognize that his senior has an instructorial duty as well as an administrative duty. And, that oftentimes interference is simply the senior's effort to perform that instructorial duty. On the other hand, the senior should remember that a man learns by doing, that intellects are sharpened by responsibility, and that instruction is best given either before or after the act and not by interference during the act. The senior should always remember the superior importance of his own problems and solve them in advance. Many seniors neglect to solve the problems appropriate to their station because they have a greater facility and consequent satisfaction in dealing with the problems of subordinates.

CONCLUSION

To develop the qualities of loyalty, initiative, and decision in military character we have found that one must acquire knowledge, knowledge of war derived from historical study and experience, and knowledge of the scheme and aims of our service. We find that for our purposes casual reading will not yield the product we are after but that the spirit of inquiry must dominate the mind that reads military history or military theory for profit. What does this event teach me that is useful in my profession? What is there in the ideas of this man that I can use? What experience in this battle carries a lesson into the future? What is that lesson? What was the influence of loyalty here? Just how was loyalty expressed? What was the effect of initiative, or its absence, and why? Of decision of character, or of its absence, and why?

So in reading a book we recommend that officers mark all these parts of a book that appear to be of especial interest. Then, that they go through the book a second time catching these parts that have been marked and reading in an hour or two the important parts of the book that took two or three days to read the first time. Then, finally, that they copy on cards extracts and digests of these parts of the book that are deemed worthy of such treatment and add the ideas, comments, and analyses that the subject provokes in their mind. The spirit of the book, or of the campaign, which is retained, as well as the extracts, digests, and comments that are recorded on the cards, are collections of material for the formation of military ability.

We find ruled cards four by six inches a convenient size. On the first line we put the subject of the card, then the name of the book, page, and author from which the quotation or digest is taken. These cards are classified, filed, and indexed by subjects, and placed conveniently at hand.

This gathering and grouping of ideas is an important step towards military education but there is a further step necessary to the proper development of the individual—and that is the precise formulation of one's own ideas. This is best accomplished by the preparation of these on the several subjects of study. A man never knows just what his belief is until he states it in black and white.

"What should I read" is a question asked by many officers. Appended to this paper is a list of books that you cannot afford to leave unread. They will introduce you to a vast field of further reading.

But knowledge alone is not enough to develop character. There must be exercise of knowledge. When a man's station or duty do not give him adequate exercise of his knowledge then, if he would progress, he should adopt the sub-caliber methods of character building employed at this college—the methods of The Estimate of the Situation, The Formulation of Orders, The Chart Maneuver, The Tactical Maneuver.

These are the general considerations which have appealed to me most strongly. The application of principles and methods to individual cases is the real problem. That is largely a matter of individual initiative. It will be admitted readily by all that for any man in the service the qualities of military character that we have been discussing are the most desirable. Let us suppose that he determines to train himself in them—what is the first step? The applicatory system establishes in us the habit of considering each situation a problem to be solved. The solution of the problem confronting the officer who hopes to attain the highest possible development of those qualities of character, should take the form of an estimate of the situation. This estimate should be the first step of the effort at improvement.

HIS MISSION: To develop in himself the qualities of military character to the highest possible degree. *Under ENEMY FORCES* he will set down his estimate of all his deficiencies of character. *Under OWN FORCES* he will consider all his good points, all his opportunities, and all the methods of employing them for the attainment of his mission and finally he will decide on the courses of conduct appropriate to his situation. Thereafter the will must unwaveringly adhere to the decision.

No officer is fully conscious of his own defects, so in solving such a problem as the one above where the completest information is especially desirable it is recommended that the officer endeavor to get the estimate of his associates on his character and especially their estimate of his deficiencies. What we seem to others is almost as important as what we feel to be true of ourselves.

A clear and constant perception of the goal, the will to always strive towards it, are necessary to the man who would arrive.

READING COURSE

The following books are recommended for reference, and for general reading in connection with the course. This mark (*) indicates that the subject at the head of the column is treated in the book named on the line with the mark.

AUTHOR	TITLE OF BOOK	Policy, etc.	Strategy	Tactics	Logistics
Bernetti	Fundamentals of Naval Tactics			*	
Bernhardi	War of Today	*	*	*	
Bismarck	Bismarck, The Man and Statesman	*			

Author	Title of Book	Policy, etc.	Strategy	Tactics	Logistics
Buddecke	Tactical Decisions and Orders			*	
Caemmer	The Development of Strategical Science	*	*		
Clausewitz	On War	*	*	*	
Clark	An Essay on Naval Tactics			*	
Cardennier	The Japanese in Manchuria	*	*	*	
Corbett	The Campaign of Trafalgar		*	*	
Corbett	Some Principles of Maritime Strategy	*	*		
Darrieus	War on the Sea	*	*	*	
Daveluy	The Genius of Naval Warfare	*	*	*	
Dorraesgnix	Modern War	*	*	*	*
Dodge	Napoleon	*	*	*	*
Esher	National Strategy	*			
Goltz	The Conduct of War	*	*	*	*
Goltz	The Nation in Arms	*	*		*
Griepenkerl	Letters on Applied Tactics			*	
Hamley	Operations of War		*	*	*
Henderson	The Science of War	*	*	*	
Henderson	Stonewall Jackson		*	*	
Hohenlohe	Letters on Strategy	*	*	*	
James	Modern Strategy	*	*		
Jemini	The Art of War	*	*	*	*
Kuropatkin	The Russian Army and the Japanese War	*	*	*	
Mahan	Influence of Sea Power on History	*	*	*	
Mahan	Influence of Sea Power on the French Revolution	*	*	*	
Maude	Evolution of Modern Strategy	*	*		
Wilkenson	The Brain of the Army				
Wilkenson	The Brain of the Navy				
Wilkenson	War and Policy				
Mahan	Types of Naval Officers				

G B

MINE EFFICIENCY FROM STOREHOUSE TO DOCK

By Lieutenants CHESTER R. SNOW and HAROLD G. DOUGLAS,
Coast Artillery Corps

From storehouse to dock the efficiency of a mine command will be measured by the direct ratio of the rapid and sustained delivery of complete mine groups properly assembled to the manual effort required. Under the stress of service conditions and the near approach of an enemy fleet, the rapid completion of a particular project without undue physical and nervous strain upon the personnel of the mine command is vital. The appearance of a hostile fleet must not find a garrison worn out by a long period of feverish effort of day and night preparation. Particular application of this principle may be made to the mine command of a coast defense, for every element of the mine system must be in place and ready for instant use by the time the hostile smoke clouds the horizon. The rapidity and ease—the efficiency—with which the mine command completes its project is dependent upon the two main phases of mine work: the assembling and delivery of the loaded mines, cable, and gear to the mine planter; and the placing of the loaded mines in their allotted positions. It is the purpose of this article to treat of the first phase which includes the assembling and delivery of the loaded mine and gear to the mine planter.

The system presented has, it is believed, the necessary elements of simplicity and practicability and involves the minimum of effort by the mine command commensurate with the rapid attainment of the object sought.

The general groups under which the various elements of the preparation of the group ashore will be considered are:

Arrangement of Mine Structures.
Mine Car.
Mine Case Storehouse.
Loading Room.
Assembling Room.

Small Stores House.
Cable Tanks.
Anchor Storage.
Dock.

ARRANGEMENT OF MINE STRUCTURES

It is obvious that mine structures should be built and arranged so that mine material may be taken from "in store" and delivered to the mine planter ready for planting by the fewest men in the minimum time. To reduce the handling of the various elements, to afford a continuous service of loaded cars, and to insure a clear return of empty cars for further loads, are the objects sought in the arrangement of the structures as shown by Fig. 1. The cases are loaded on a specially constructed car in the storehouse, pass thence to the loading and assembling rooms and thence direct to the dock, each element having been handled but once when originally put in place. The small stores are loaded at the small stores house and run direct to the dock. The cables, cut, measured, coiled, and loaded on cars at the cable tank and parade go direct to the stern of the planter. The anchors, loaded on cars at the anchor platform have a direct track to the dock. All empty cars return over tracks other than those used for loaded cars. Above these considerations stands the most vital condition of all mine work, that the assembled material must be as perfect as it is within the power of the shore sections of the mine command to make it. To insure this condition in the system outlined here, each operation of assembling has been so isolated that each cog of the machine has but one function and each function can be absolutely and clearly supervised; and the various functions are so linked up that the cogs of the machine mesh without friction to form the perfect whole.

THE MINE CAR

The mine car has been designed to fulfill the following requisites:

1. A car which will hold the mine in the loading position, thus doing away with loading holes or frames in a loading room and consequent double handling of heavy cases.
2. A car which will be easy to load and unload.
3. Six mines (weighing, loaded, about three tons) were determined as the proper load for one car and still retain ease of handling.

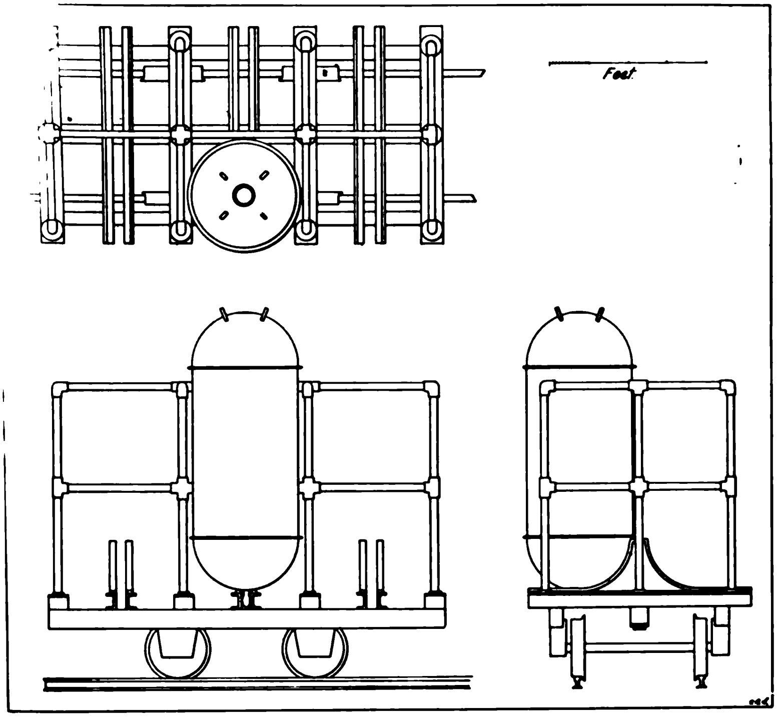

FIG 2.

1909

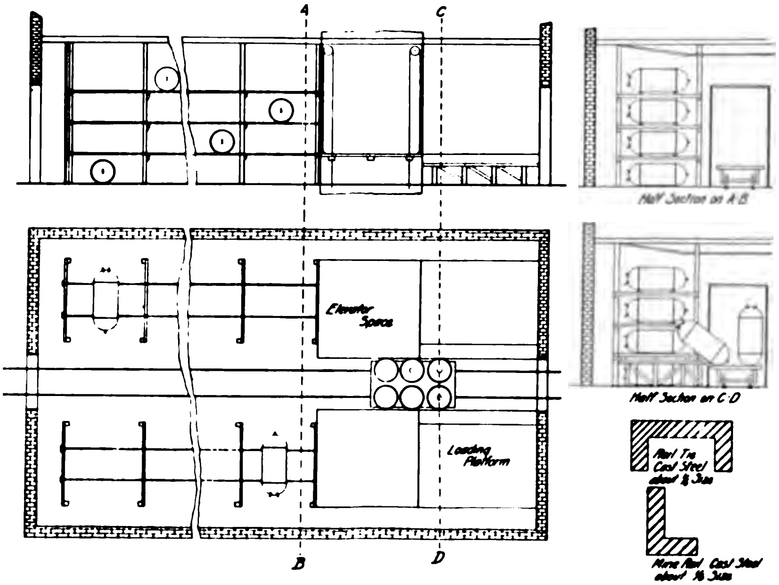

FIG. 3.

1910

The car is a frame on wheels for carrying six mine cases. The car proper is constructed of wooden timber, angle iron seats for the mines, and supporting frames of 2-inch pipe. The extreme width of the car when loaded is 6 feet; the extreme length, loaded, is 10 ft. 2 in.; the extreme diagonal length, loaded, is 11 ft. 8 in.

The mine seat is formed (Fig. 2) of two angle irons securely bolted to the three main longitudinal members of the car, and extending the full width of the car. Upon the upper surface of the angle irons are riveted two-inch half-round metal members which are curved upward in the center of the car to the radius of the mine hemisphere. The angle irons and half-round members form the seat and guide for the mine case. Two-inch pipe construction as shown in the figure is used to form a supporting frame for the mine.

THE MINE CASE STOREHOUSE

The mine case storehouse should be a building specially constructed for the storage and handling of mine cases. Fig. 3 shows such a storehouse.

A track runs completely through the center of the storehouse to permit a continuous stream of cars; also to provide a storage space for assembled mines on cars, if it is not desired to plant them the same day they are assembled.

There are rails on which cases are stored in tiers, elevators for handling cases to or from the upper tiers, and loading platforms for loading the cases on cars. The rails upon which the mines are stored are supported on suitable cross ties which are in turn supported on brackets secured to uprights. The rails and supports are all joined by bolts and nuts so that its arrangement can be changed to accommodate a change in size of the mine case. The elevator should be of the hand power type of a capacity of three mines. The loading platform is a simple platform at the height of the second tier of mines, sheathed with smooth iron so that the cases may be easily rolled or slid across it for loading on the car. The mines in the various tiers are rolled to the loading platform along the rails on which they are stored, using the elevator for the bottom and upper tiers.[1]

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[1] [By placing the elevators at the back of the storehouse, the second tier could be kept filled at all times. The loading platform would immediately adjoin the tiers and no interruption in loading cases on the cars could occur due to waiting on the elevator to bring cases from the upper or lower tiers. Editor.]

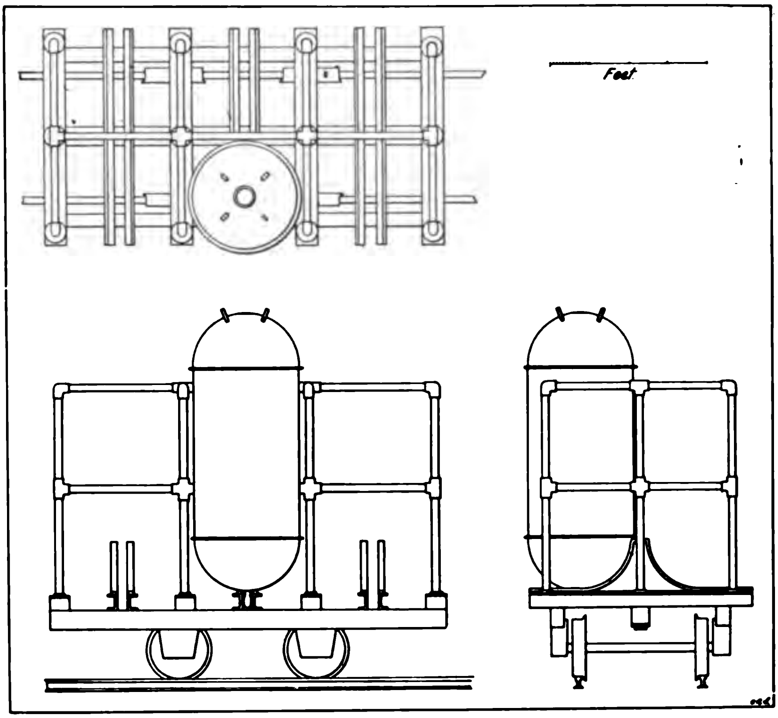

Fig 2. 1909

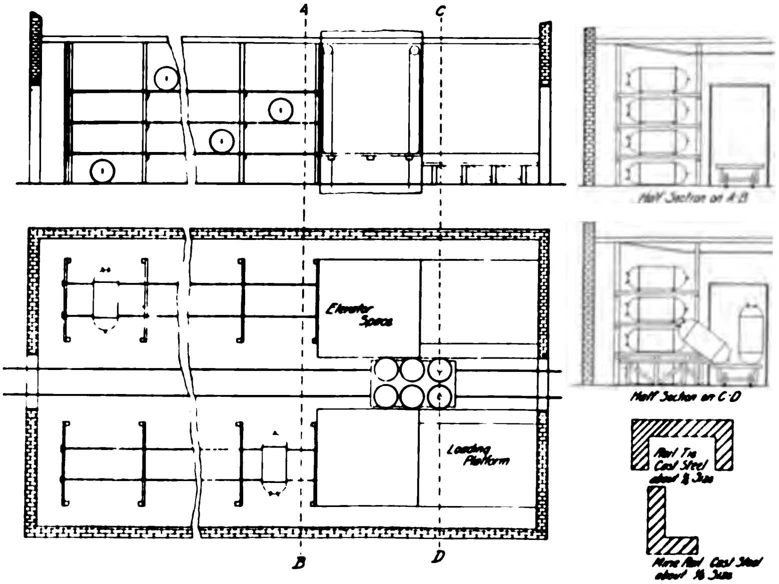

Fig. 3. 1910

To place the mine cases on the car from the loading platform in the storehouse, the case is placed with the maneuvering ring end projecting over the mine seat of the car. Two or three men then up-end the case (Fig. 3), the maneuvering

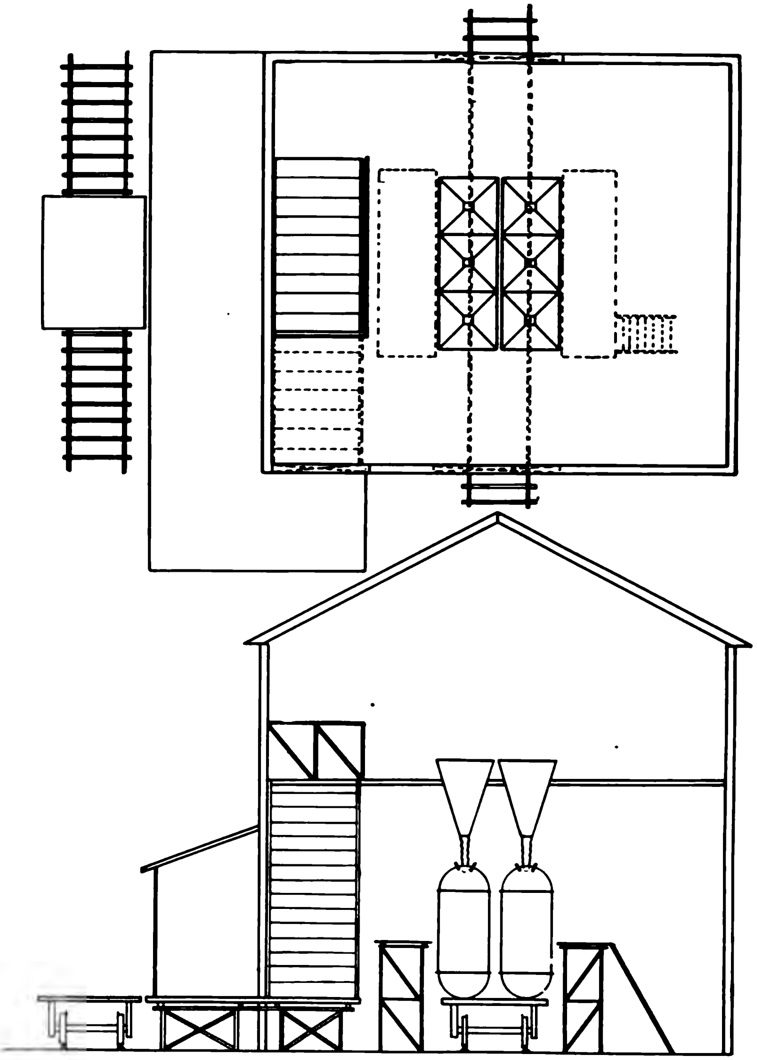

FIG. 4.

ng engaging in the slot formed by the angle iron of the mine at and guided by the half-round curved members, until the se assumes an upright position when it is secured to the pe car frame by chain and hook.

LOADING ROOM

The loading room consists of a frame building about twenty-five feet square with car track running through the center. At one side is a covered receiving platform with car track or road from magazine leading to it. A wide flight of steps leads from this platform to the upper story. Inside the structure and close to the tracks is a light platform reaching to a convenient height on the mine cases on the cars. The upper story, floored over, contains six large hoppers with chutes of canvas at the lower ends for insertion in the mine cases. The lower story need not be shut in by walls. The operation of loading the mines is as follows:

The mine car with six cases is placed in position beneath the chutes. A man on the platform on either side of the track inserts the canvas chutes in the mines. Meanwhile the explosive is brought from the magazine by car or wagon, unloaded on the receiving platform, carried upstairs and opened. Four boxes, or any required quantity, are then dumped into each hopper, stirred with a stick, and the mines having received their charge give place to the next car load.

ASSEMBLING ROOM

The assembling room is a frame building 36 feet by 50 feet divided by suitable partitions into central assembling rooms, plug rooms on either side, and storerooms for plugs, transformers, caps, and various small parts. Through the center of the assembling room runs the track from the storehouse and loading rooms. At a convenient height alongside the tracks are the working platforms, connecting with the plug rooms on either side by suitable staircases. The working platform is continued the full width of the building at the forward end to provide storage for mine caps. The space below this on the plug room level affords space for plugs, transformers, and fuse cans. The plug room contains work benches providing for the assembling of six plugs in each room simultaneously. Two testing tables in each room are arranged conveniently to a sliding panel communicating with the working platform in the assembling rooms. The assembling proceeds as follows:

The plugs, assembled and tested in the plug room, are passed through the sliding panels to the working platform. Meanwhile the first mine car with six loaded mines is brought into the building. The assembling detail inserts plugs in the cases, the first mine car then giving place to the second where the same operation is repeated. Meanwhile the first car proceeds to the forward end of the assembling room where the mine cap detail affix the mine caps.

The car of six finished mines then goes to the dock. At the dock three hooks connected by suitable slings, spaced properly by a bar, are inserted in the upturned bale rings. The planter boom by means of this tackle picks up three of the mines at a time and places them aboard. The car then returns by the return track to the forward end of the mine case storehouse for a fresh load.

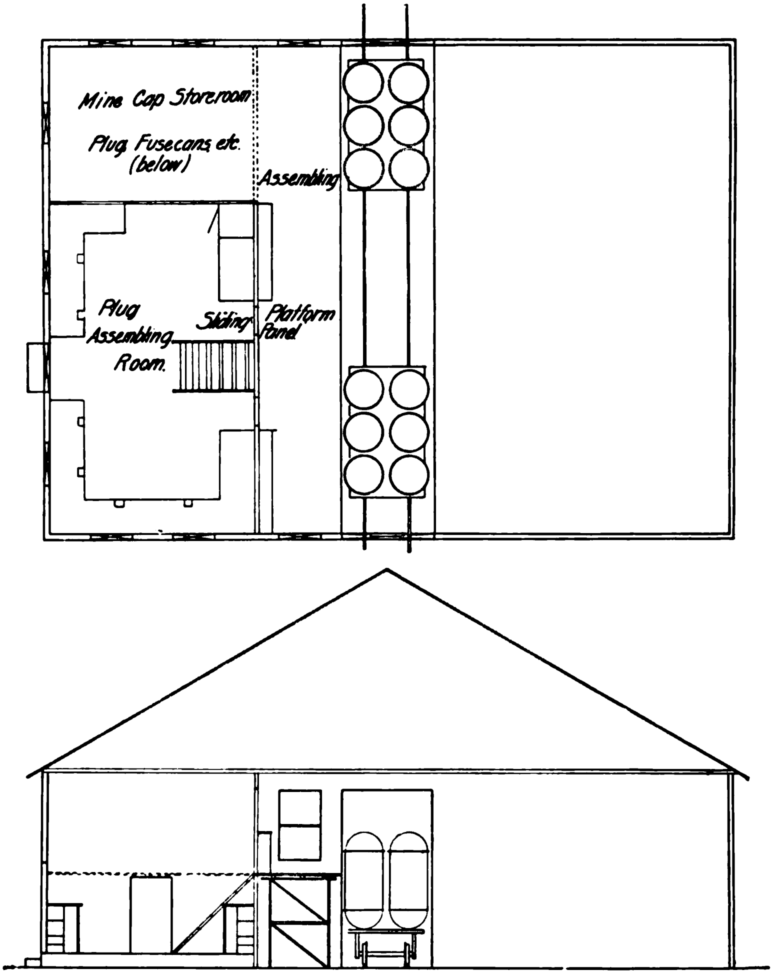

Fig. 6.

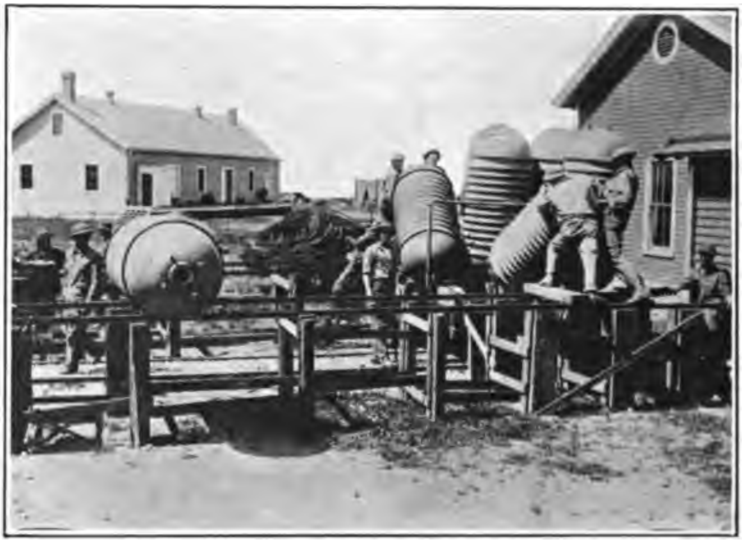

Fig. 6. 1913

(Note.—Figs. 6-11, inclusive, are referred to in the last paragraph of article, page 332—*Editor*.)

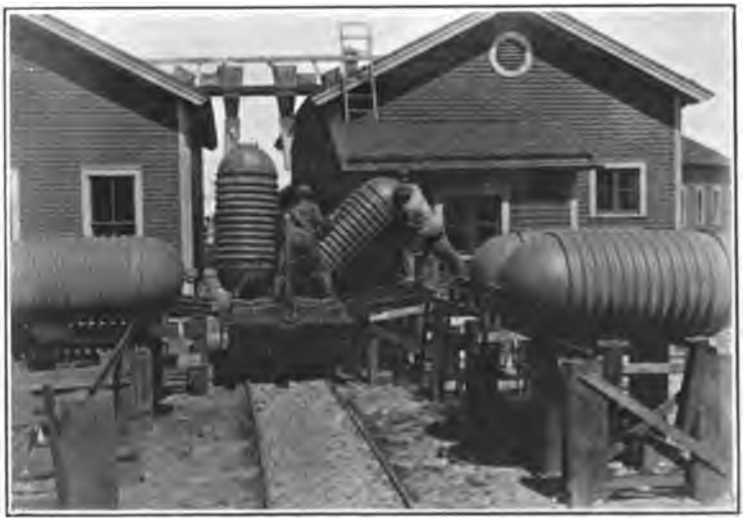

Fig. 7. 1914

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CABLE TANKS

The cable tank, situated near the dock to shorten hauls heavy cable, also faces the open parade. (See Fig. 1.) erhead cranes provide means of placing reels on cars or on

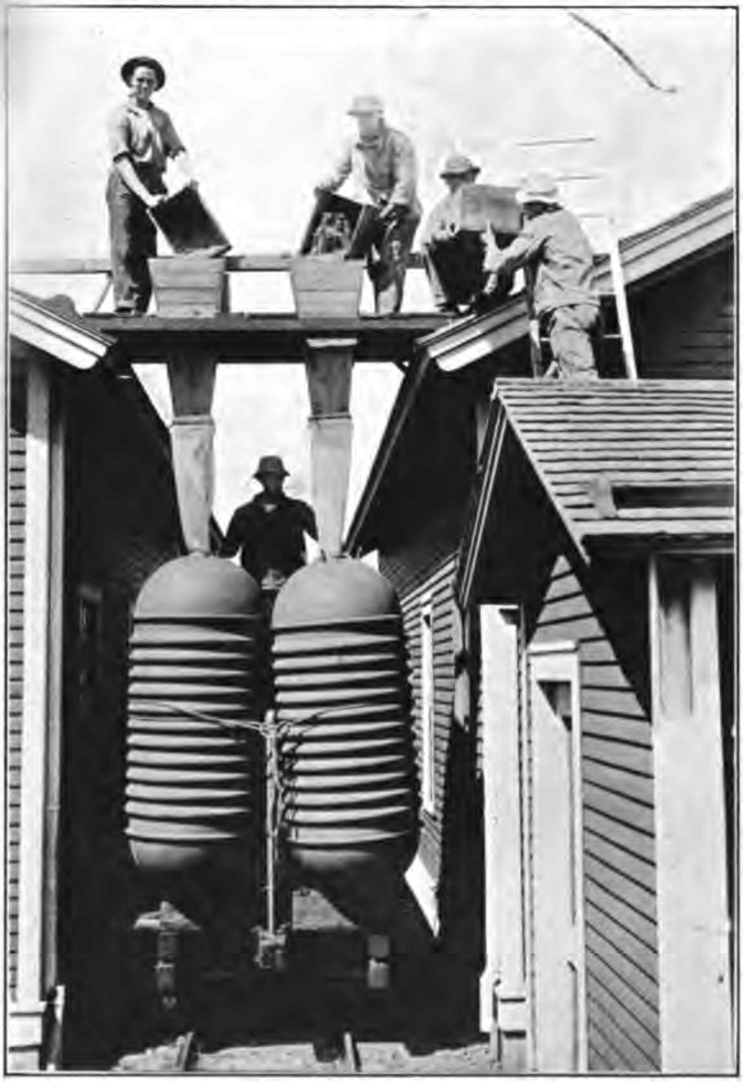


FIG. 9. 1916

parade, preparatory to measuring off lengths. The cable tank should be divided into sections holding about six reels each. This will save draining and refilling the whole tank upon many occasions.

ANCHOR PLATFORM

For storing mushroom anchors, platforms flush with the car decks should be provided. The clearance between platform and car should be such that no gangways are needed in rolling anchors on car (Fig. 1). The anchors will be stored on edge on this platform. If painted, they will suffer no amage from weather. Automatic anchors when used would

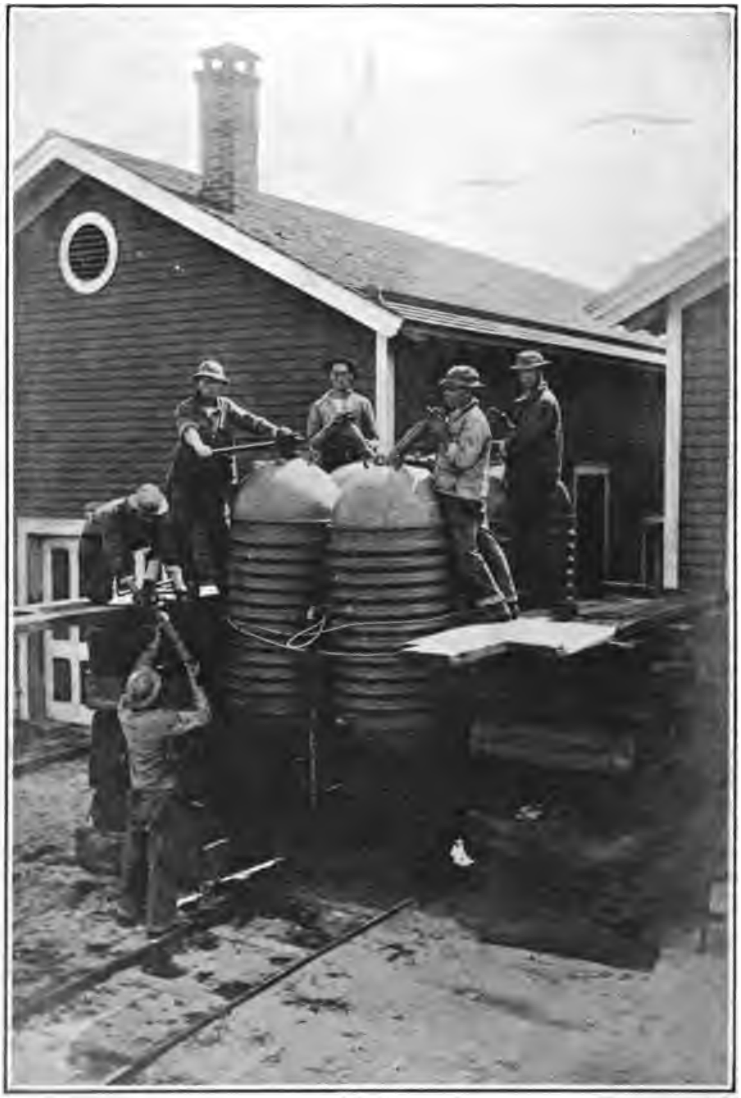


Fig. 10. 1917

be provided for in the small-stores house, an overhead crane being used for loading them on cars. Cars should be planned for as short a haul as possible for the heavy anchors.

THE DOCK

The face of the mine dock should be of such length that both forward and after ends of planter can be loaded simultaneously. Where the project is large, requiring several planters, this frontage should be suitably increased. Where there is a large rise and fall of tide, suitable ramps should be provided for carrying cable aboard. It is essential that the car track run the full length of the planter and that it be a double track in order that the loading of both ends may pro-

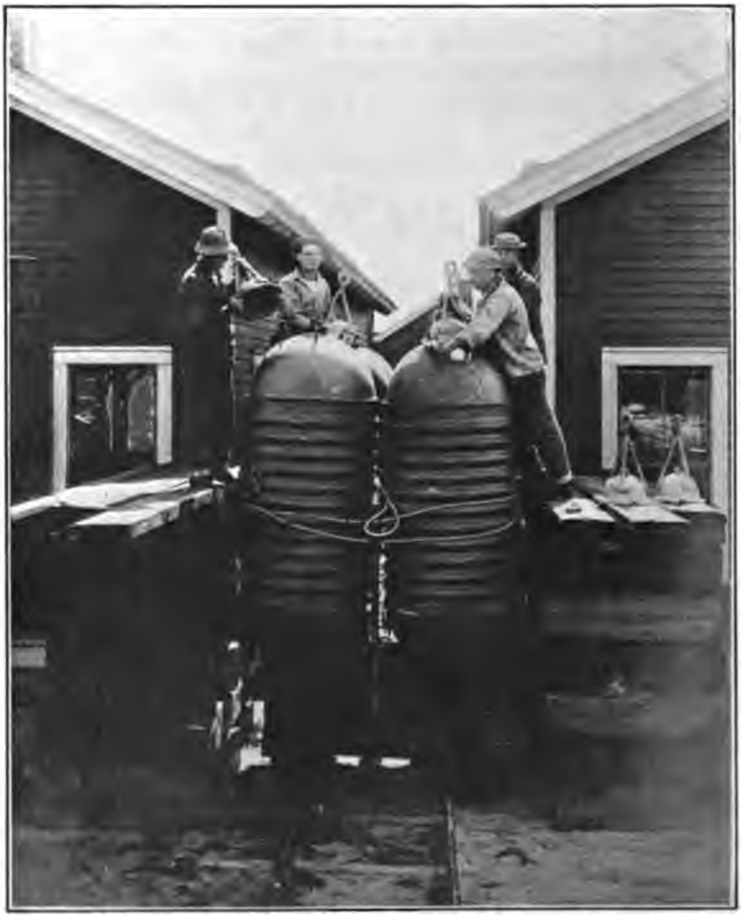


FIG. 11. 1918

ceed without interference. With the exception of the face, the dock need not be wider than necessary to provide room for the car tracks.

In conclusion, a brief summary of a few of the advantages of this system may be stated, as follows:

1. Mine cases are handled but once, no differential blocks or overhead cranes being necessary.
2. A minimum number of skilled men are required, the plug room details being the only details requiring special training.
3. Each operation is carried on at a different place, permitting of the most careful supervision of that operation.
4. Each chief of detail can be held strictly accountable for the work of his detail and his own particular part of the mine.
5. Fewer men are required than under any other method.
6. Fewer cars are required than under any other method; each car holding six No. 50 mine cases—under other methods, three.
7. The gravity method of handling the explosive is obviously superior to any method requiring shoveling.
8. The lessened handling of cases and anchors admits of greater speed in the delivery of the complete group to the planter.
9. The systematic preparation of each mine tends to the production of an efficient mine field.

It is to be noted that no mine testing tank is provided. It is believed that with proper care in assembling, this test will be found unnecessary. A test with a water head of a maximum of five to six feet is possible in the present loading room tanks; when the mine is planted, the water head is twenty or more feet. The tank test is also much reduced in value unless carried on for a considerable period of time—say twenty-four hours. As the average tank will not hold more than ten No. 50 cases, it is out of the question under service conditions to leave the mines twenty-four hours in a tank, as this would require forty-eight hours for the preparation of each group. With proper care in assembling assured by the competent supervision and the specialization of details of the system here outlined, it is believed that the percentage of leaky mines will be nil.

Figs. 6 to 11 show a working model of this system constructed at Fort H. G. Wright. This was built from such material as could be found at the post with the object of showing the simplicity and convenience of this method of loading.

A HORIZONTAL BASE SPOTTING BOARD

By Second Lieutenant LAWRENCE A. McLAUGHLIN,
Coast Artillery Corps

Description

The "Spotting Board" consists of a plain one-inch board one foot wide by five and a half feet long, to which is secured the fixed arm *A*, a one-inch metal arm graduated from 0 to 18,000 yds. (scale 300 yds. to the inch) as shown in the illustration. (See page 334 for illustration.)

The target block *B* slides along the fixed arm *A*, to which it may be clamped at any range by means of the clamp screw *C*.

The spot arm *D* is a one-inch metal arm eight inches long and graduated from 0 at the center of motion to 1000 yds. in either direction along its center line (scale 300 yds. to the inch). It pivots on the target block *B*, and is secured thereto by means of a countersunk rivet. The center of this pivot represents the position of the target. The spot arm may be set at any angle to the fixed arm, up to 180°, by means of the graduated arc *E*, which is graduated in degrees.

One end of the spot wire *W* is secured to a ring which pivots on the spotting station *S*. The other end is secured to the index box *I*. The spot wire travels over the spot arm and is just tangent to its upper surface. A wire spring near the index box keeps the wire taut. The index box (reading to 0°.05) slides on its arc, which is graduated in degrees from 0° to 6° with 3° as normal—the same as the sight used for observation.

Operation

The spotting board is installed in a corner of the plotting room.

Before firing begins, the operator of the board will set the spot arm *D* to the angle obtained by subtracting the secondary and gun-arm azimuths called out by the secondary arm setter and assistant plotter to nearest degree for any plotted point, and will change the setting only as often as this angle changes

appreciably. This determines the angle at the target. The operator then slides the block to range from secondary called by plotter, clamps it, and changes the setting only as often as this range changes appreciably. Thus, with little effort, the board is kept set for a "spot."

A spotter in the secondary station, equipped with a sight and in direct telephone communication with the operator of the spotting board, follows the target with his vertical wire, moves to the splash, and calls the actual reading to the operator who sets the index box and reads the over or short from the intersection of the spot wire with the spot arm.

The results obtained will be accurate except where there is a very large error in gun deflection, in which case that particular "spot" will be disregarded.

glass. On the lights now installed in our service, there is no device for giving an image of the arc.

The purpose of this apparatus is to provide a cheap, easily made, and efficient means for projecting a full sized image of the searchlight arc outside the drum and in such a position that the operator can readily observe the condition of the carbons, the length of the arc, and whether the arc is in focus.

By making two marks on the cross-section paper showing the normal length of the arc and the correct position of the carbons when properly focused, the maintaining of a proper length of arc and keeping the light focused become very easy even to an unskilled operator.

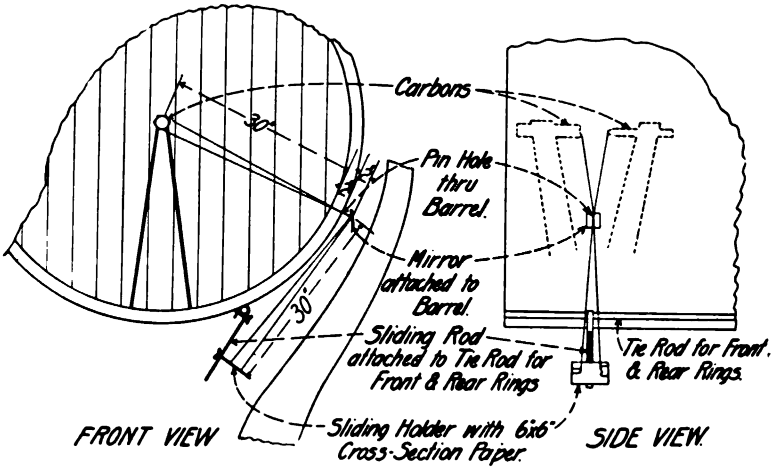

Carbons
30°
Pin Hole thru Barrel
Mirror attached to Barrel
30°
Sliding Rod attached to Tie Rod for Front & Rear Rings
Tie Rod for Front & Rear Rings
Sliding Holder with 6x6" Cross-Section Paper
FRONT VIEW
SIDE VIEW

Fig. 1 1921

The special merit of the device is that it provides a clear, full sized image of the arc without the use of lenses, and yet in spite of a 32-inch focus, keeps the image in a convenient position near the searchlight drum.

The device as shown has been installed on one of the 60-inch General Electric searchlights at Fort Monroe, and has been found so satisfactory that the Coast Defense Artillery Engineer desires to have each light of the Coast Defense equipped with a similar apparatus.

Construction

The materials for constructing the apparatus may be found among the scrap material at any post. The quality or

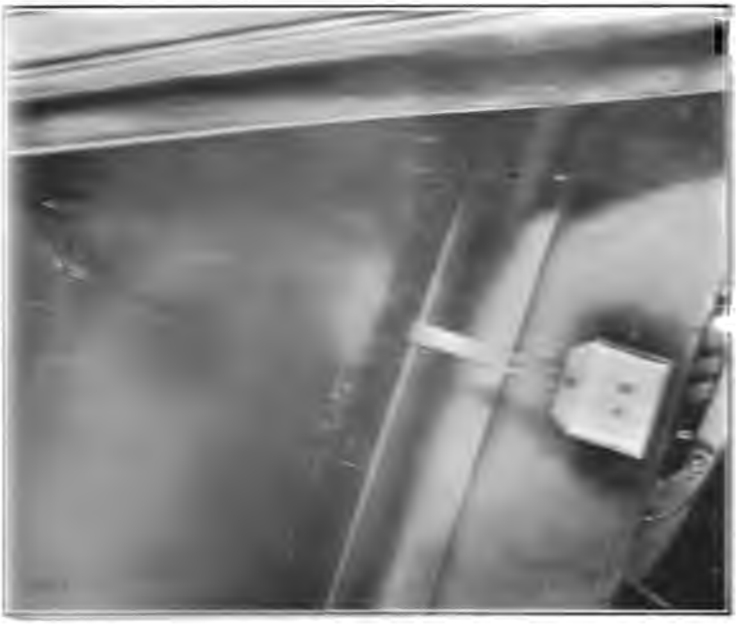


Fig. 1

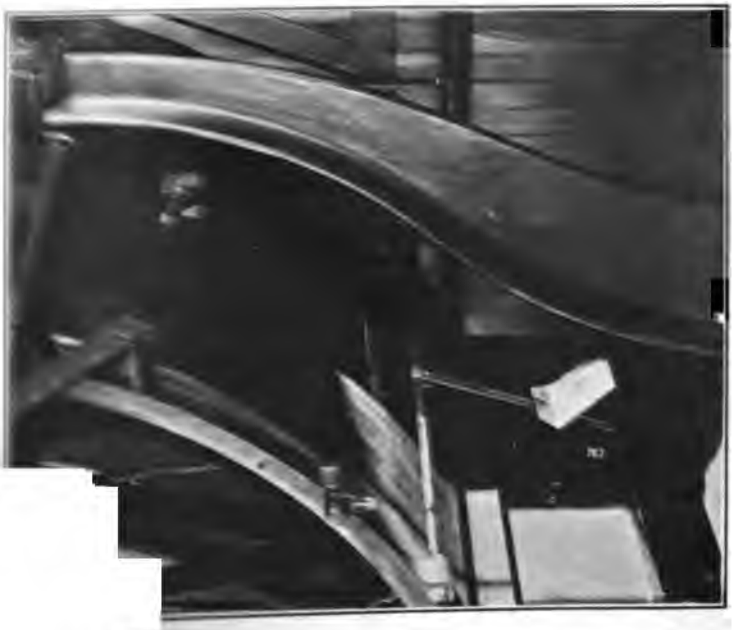


Fig. 2

shape of the mirror is of no consequence—any small scrap of broken mirror will answer.

The rod for holding the mirror passes through a small hole in the drum and is clamped in position by tightening two nuts, one inside and one outside the drum.

The sheet metal holder of the cross-section paper may be bent so as to enable the operator to see the image from any particular position desired.

If so desired, the image on the cross-section paper may be made clearer by surrounding the cross-section paper with a hood of sheet metal or of dark paper or cloth. This tends to exclude all light except that forming the arc image.

The small expense and ease of construction of the apparatus herein described, make it practicable, if so desired, to install the device on both sides of the searchlight.

arget range detachments, details for the recruiting service, nd details for administrative purposes at Headquarters, staff ffices, depots of supplies, etc., etc.

Detachments assigned to vessels of the fleet constitute a part of the ship's fighting force. Each marine detachment on board ship is organized as a gun division, and mans a part of the ship's battery. So far as the military training of the detachment is concerned, the detachment commander is vested with practically the same authority as the commanding officer of an Army company. In the battery drills, the ship's gunnery officer represents the battalion commander, and the commanding officer of the ship the regimental commander. The marine detachments of a fleet, squadron, or division, are also organized into provisional regiments and battalions for service on shore. For this service, the regimental commander is the fleet or squadron marine officer; the battalion commanders, the division marine officers; and the company commanders, the detachment commanders.

When on board ship a detachment forms a part of the general mess of the ship, and is rationed by the Navy paymaster, the detachment commander having no responsibility or duty in connection therewith. When serving on shore as a part of Marine Corps landing forces a detachment is rationed like a company, a detachment commander having the same responsibility for the detachment mess as a company commander.

The detachment commander on board ship also acts as a representative of the Quartermaster's Department in so far as clothing, arms, accoutrements, and camp equipment of all kinds, are concerned. He keeps each man's clothing account, issues clothing to him, and renders the regular returns to the Quartermaster's Department. He also prepares the detachment pay rolls and muster rolls, keeps the service record books, and makes all routine returns and reports concerning personnel to the headquarters of the Corps. The paymaster of the ship pays the men on the presentation of the pay roll submitted by the detachment commander.

The detachment is, of course, under naval discipline, and all punishments are assigned and courts awarded by the commanding officer of the ship. In all respects marines regularly stationed on board ship are governed by the same regulations as are the other members of the crew.

The officers and enlisted men of a detachment serving on board ship are not permanently attached to it, but are transferred ashore upon the completion of a tour of sea service which is ordinarily about two years in duration. Vacancies among the enlisted men in the detachment, no matter how created, are filled by transferring men from a shore station—usually men who have just completed the course of instruction at a recruit depot.

* * * Original appointments of noncommissioned officers of the Marine Corps are made: *1st,* By the Major General Commandant, with temporary or permanent appointments; *2nd,* with temporary appointments by commanding officers of posts and expeditionary forces outside the continental limits of the United States; *3rd,* with temporary appointments by commanding officers of vessels of the Navy having organized marine detachments * * *; *4th,* with temporary appointments by commanding officers of organized marine detachments on armed transports of the Navy * * *; and *5th,* with temporary appointments by officers in charge of recruiting divisions, for detail on recruiting duty.

* * * Noncommissioned officers hereafter appointed by the Major General Commandant will receive, upon original appointment, a folder in which all warrants, letters of appointment, reappointment, or reduction, discharge certificates, letters of commendation, etc., will be kept. Noncommissioned officers appointed by the Major General Commandant will receive parchment warrants in evidence of appointment, except that first and gunnery sergeants for temporary duty will be appointed by letter. Officers authorized to appoint or to reappoint noncommissioned officers will provide them with warrants, or letters of appointment or reappointment, to be attached to their warrant records. Noncommissioned officers shall carry their warrant records with them, but may deposit them with their service-record books for safekeeping, if they desire. Warrant records, with their proper contents, are the property of the noncommissioned officers to whom issued, and shall not be forfeited by them. Warrants will not be forwarded to Headquarters, U. S. Marine Corps, nor will endorsements be made upon them.

Folders will be supplied to all corporals now holding appointments from the Major General Commandant; noncommissioned officers who have the warrant record books heretofore issued will retain them, making the necessary perforations for attaching additional papers.

* * * The reappointment of a noncommissioned officer will be evidenced by a letter addressed to him by the reappointing officer, a signed copy of which will be forwarded to the Major General Commandant. This letter will state the fact and date of reappointment, and the reason therefore, such as "Upon reenlistment------(date)------," or, "Upon relief from recruiting duty," etc.

Noncommissioned officers reappointed upon re-enlistment, or upon relief from recruiting or other duty for the performance of which they were reduced, will immediately assume the rank, insignia, and duty, and will be entitled to the pay of their respective grades, from the date of reappointment.

* * * When recommendation is made for the reduction of a noncommissioned officer as being undesirable, or unfit for noncommissioned rank, or because of misconduct, a full report of the circumstances will be made to the Major General Commandant with a statement of the man concerned, or his declaration that he has no statement to make. Recommendations for reduction will not be made by telegraph.

A sergeant major may be reduced by either a general or a summary court martial. Under general court martial, the regulations prescribe that in all cases in which the sentence imposed on a noncommissioned officer involves confinement it should include reduction to the rank of private.

A summary court martial may reduce any noncommissioned officer to the next inferior rating, unless the man's current enlistment record shows that he was promoted to his present rate from some inferior rating other than the one indicated by the table in Paragraph 619 of the Navy Regulations, in which case his reduction shall be to the inferior rating from which he was last advanced. Noncommissioned officers may be reduced in writing by order of the Commandant of the Corps. The position of a sergeant major is not different from that of any other noncommissioned officer.

In order to perform satisfactorily the duties enumerated in (b) and (c), provisional companies are organized. These companies are further organized into provisional battalions, regiments, and brigades. A marine corps company consists of approximately 100 men. The personnel of this company is subject to change in the same manner as the personnel of a ship's detachment. In fact, it is a rare thing for an officer to be attached to a company for a longer period than three years. Each company is assigned a certain quota of noncommissioned officers. Noncommissioned officers, however, are not appointed for any particular company or detachment, but for the entire Corps, and a vacancy created in a company or detachment may be filled either by transfer from another company or detachment, or by promotion of a man belonging to the company or detachment in which the vacancy exists. In this way, places are kept open for noncommissioned officers upon re-enlistment. This is necessary as all noncommissioned officers are reappointed provided they re-enlist within three months after their discharge.

So far as the Navy Regulations permit, the internal affairs of our companies are administered in a manner similar to that in which they are administered in the Army. Company commanders have no authority, however, to inflict punishments on their men, unless the company be serving independently on detached duty. When serving as a part of a larger command, the regimental commander, or battalion commander, as the case may be, has the same authority as to discipline as the commanding officer of a naval vessel, and personally investigates offenses and assigns the punishments authorized by the Articles for the Government of the Navy, or awards trial by court martial.

The authority of a company commander concerning the military training of his company is the same as that of a company commander in the Army.

Companies serving on shore receive the Army ration ordinarily; and, when not forming a part of a general mess, each company has a company mess under the supervision of the company commander. These provisional companies therefore accumulate company funds. The company fund account is audited just as in the Army.

When a company is disbanded, as is sometimes the case, the company fund is divided pro rata among the post funds to which the personnel of the company is distributed. On the other hand, when a provisional company is organized for expeditionary duty, by the transfer to it of detachments from several posts, the pro rata share of the post fund or post exchange fund is sent to the company commander in order to form the nucleus of a company fund. Company commanders prepare muster rolls, pay rolls, and keep the service records; they also render the routine reports required by regulations and orders. Under existing regulations they do not keep the clothing accounts of the men, this being done by the post, regimental, or battalion quartermaster. When serving on detached duty, however, company commanders are made accountable officers, and render regular quartermaster returns for public property, clothing, arms, accoutrements, etc.

All accoutrements are marked with the letters "U.S.M.C." before issue to the service. Rifles and pistols are not marked, but are accounted for by the serial numbers thereon.

In regularly organized companies, accoutrements are marked in black with the distinguishing number of the company and number of identification of the man to whom issued. In these cases, the man retains his identification number as long as he remains in the company, and upon transfer from the company another man is given his identification mark. The accoutrements themselves remain with the company until worn out and surveyed. In provisional companies, accoutrements are not marked for the individual man.

The regimental number is not marked on the accoutrements. The companies in the Marine Corps are not lettered for each regiment, as in the Army, but are numbered consecutively.

In the barracks, the post quartermaster is accountable for all arms and accoutrements at the post, the company or detachment commander being the responsible officer, and he signs the memorandum receipts to the post quartermaster for all property in the possession of his company. He requires each enlisted man to sign a memorandum receipt for all property in the man's possession. In the field, the regiment is the unit of accountability; and under normal circumstances the regimental quartermaster is accountable for all property in the regiment; but in unusual cases, where the companies or battalions are serving on detached duty, battalion quartermasters, or company commanders, may be made accountable officers, in which case they render returns direct to the Quartermaster at Headquarters.

In order to perform the class of duties described in (d), a detachment of sufficient size to properly protect the navy yard, naval magazine, or radio station, is assigned thereto. The primary duty of this detachment is to guard the enormously valuable plants located at these places. The size of these detachments varies from 7 or 8 men to 200. They are not organized into companies, but are designated as "barracks detachments." The post commander has the control and direction of these detachments, and is responsible for the proper performance of the guard duty. His authority is analagous to that of the commanding officer of a naval vessel. The detachment constitutes a general mess, and companies stationed at the post form a part of this general mess. The post commander, or some other officer under his command, detailed by him, is responsible for the preparation of pay rolls, muster rolls, and other returns. The post quartermaster has charge of all property, the issue of clothing, etc., etc.

A similar system is followed in connection with the detachments enumerated in (e).

Companies do not accumulate such property as billiard tables, rugs, furniture, libraries, electroliers and other equipment of the army company's day room.

Articles for the recreation and comfort of the enlisted men are installed in the post exchange, which usually includes a store, restaurant, reading and writing rooms, library, barber shop, and also tailor, shoemaker, and laundry services.

As there is always a "barracks detachment" at the permanent shore stations to use and guard the property left behind by outgoing troops, detachments can be organized and leave the station in a few hours without being obliged to pack, weigh, mark, and store any of the articles usually found in the "day room."

In keeping records, the loose leaf system is largely used and every effort made to reduce paper work to a minimum.

The consolidated monthly muster roll of the entire corps consists of a bound volume of "loose" leaves with the outside dimensions being fifteen inches long, nine inches wide, and about four inches thick.

It will be seen from the above that the organization of the Marine Corps is made to suit the duties required to be performed. If a company of the normal size is found to be too small or too large for the performance of the mission assigned to it, it may be increased or decreased in size; or additional companies may be detailed, and a provisional battalion be organized. If a regiment of a thousand men is considered suitable for the performance of certain expeditionary duty, a regiment of that size is detailed. If seven hundred men are considered sufficient, a regiment consisting of seven hundred men is detailed. If three or four hundred men are needed, a battalion is sent.

The rationing and supplying of organizations are provided for in a similarly flexible manner. On board ship or when forming a part of a ship's landing force, detachments receive the Navy ration, and are rationed by the Navy paymaster. When serving on shore as a purely Marine Corps force, the Army ration is ordinarily issued; but if it is impracticable to obtain the Army ration, the Navy ration may be issued. When Marine Corps paymasters are available, marines are paid by them; when they are not available, they are paid by Navy paymasters.

Medical officers and enlisted men of the Hospital Corps of the Navy are assigned to duty with the Marine Corps, and perform practically the same duties as the Medical Corps of the Army.

Marines also may be detailed for service with the Army, as was recently done at Vera Cruz, Mexico, where a brigade of approximately 3000 marines served as a part of the Army of Occupation, for a period of about six months. When engaged in service with the Army, marines are governed by the Articles of War, all court martial procedure and disciplinary matters being changed from the Navy to the Army system.

The service of marines is as varied as their organization is flexible. At the present time, Marine Corps companies serve as infantry, field artillery, engineers, signal troops, submarine mine companies, five-inch gun companies, searchlight companies, etc., etc.

the new track. The old track is continued until the new one is thoroughly established. Thus there is no interruption in the sequence of ranges.

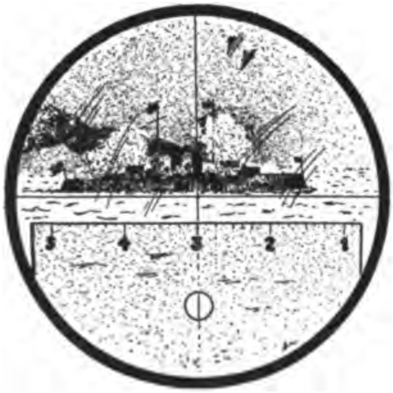
The range recorders at the guns are provided with large blackboards attached to the walls of the emplacements, and with chalk. These boards are divided into blocks, and each block is permanently numbered at its left in red

3 –
1 –
2 –

the numbers corresponding to Third, First, and Second Bells. The ranges are recorded in sequence, as received, opposite the proper bell-numbers.

The gun commander has a stop-watch synchronized with the time-interval clock. The time-interval mechanism is adjusted so that there are three strokes of the bell at the even minute and at thirty seconds, two strokes of the bell at twenty seconds and fifty seconds, and one stroke of bell at ten seconds and forty seconds. The gun is fired at the last stroke of the bell. At or just before the command "Elevate," he selects the nearest bell ahead prior to which the laying should be completed. He calls out "----Bell." The range recorder calls out in a loud voice the corresponding range. The range setter verifies this range by glancing at the board, and sets the range. Should the range not be set in time for firing on the bell announced, the gun commander calls: "Relay. ---Bell."

The accessories to the time-range board are a soft pencil, an eraser, and a xylonite triangle.



THE GEBELIN RELOCATOR

By Ordnance Sergeant JOHN GEBELIN, U. S. Army

This relocator was designed for use with field guns in connection with land defense of coast forts. The device can, however, be used as an emergency position finder for any gun or battery, relocating the target from any position finder in the fire control system of a post.

The illustration shows the board constructed from material on hand at Fort Hunt, Va. It is made of wood which, of course, is susceptible to changes of temperature in a greater degree than would be a board constructed of metal. The outside dimensions of the board are 37 inches by 26½ inches.

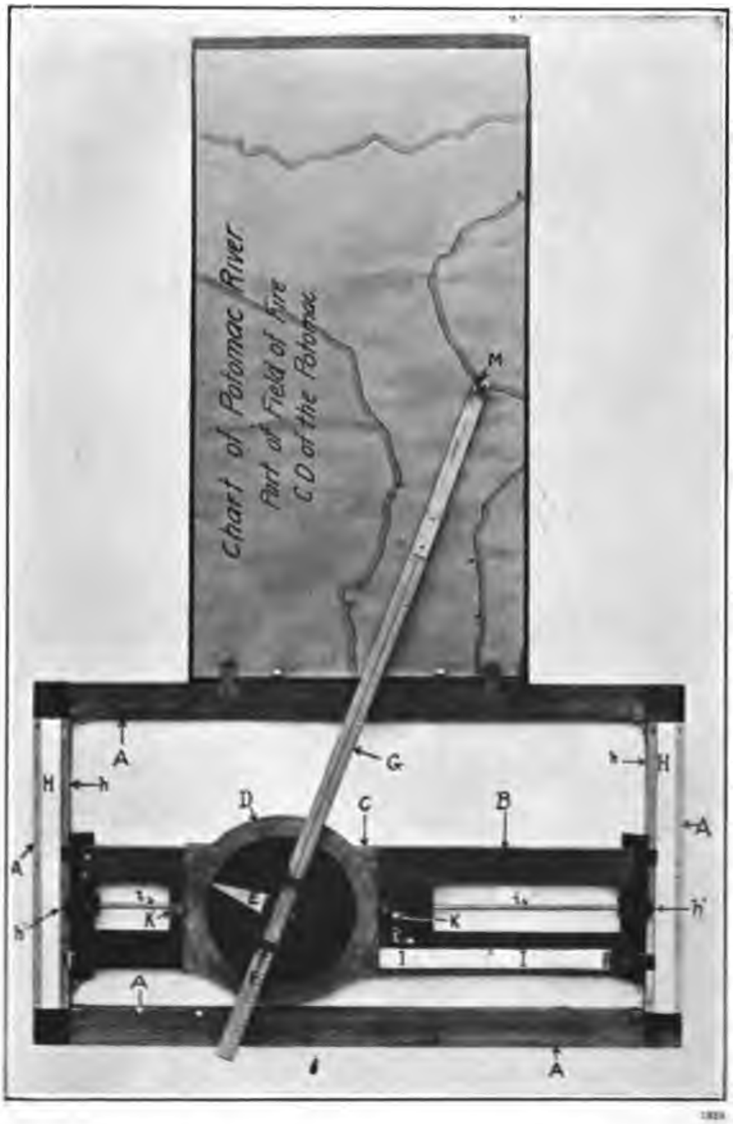
The device consists of:

Base *A* (wood).
Sliding frame *B* (wood).
Sliding frame *C*. This frame slides either to the right or left of board; the frame *B* slides at right angles to *C*.
Azimuth circle *D* (metal).
Azimuth pointer *E*.
Arm slide *F* pivoted at center of *D*.
Range arm *G* (wood), slides in *F*.
Longitudinal displacement scales *H-H*.
Longitudinal displacement slides *h-h*.
Longitudinal displacement pointer *h′-h′*.
Lateral displacement scales *I-I*.
Lateral displacement slides *i-i*.
Lateral displacement pointer *i′*.
Azimuth securing screws and lugs *K-K*.
Range arm pin *M*.

To use with field guns, or batteries, where no azimuth circle is available, a wooden frame with azimuth circle can be used, or a sectional wooden azimuth circle to be pegged down to the ground, either in rear, or front, of guns.

Operation of device, is as follows:

Board is laid flat on a table, or on the ground, and can be oriented by means of adjustable screw *K-K*. The azimuth circle turns on its own center. The zeros of both displacement scales can be either the directing gun positions, or a known point such as the primary or secondary of a position finder system.



The displacement is measured from the known point used, and set off by sliding frame *B* forward or backward until distance is marked by pointer *h'*, or, as in the figure, pointer is on mark designating station for which board is to be set. (Note: The illustration represents a board prepared for the C. D. of the Potomac, with co-ordinates of batteries, etc., already marked on both lateral and longitudinal scales. In this case, of course, no measurements are necessary.) The sliding frame *C* is then moved to right, or left, until proper distance is marked by pointer *i'*, or until pointer is on station desired. This locates gun, or battery, with reference to the known point used. The two frames are so constructed as to remain in position set.

In case only scales are used, and no co-ordinates of batteries, position finders, etc., have been marked on *H-H* and *I-I*, the operation is as follows:

A target is located by primary, secondary, or gun arms of the plotting board used and the range and azimuth of same set off by the pointer *E* and range arm *G* on the board; the sliding frames set at zero, and the gun for which range and azimuth are wanted being 400 yards, or feet, in front of, and 300 yards, or feet, to the right of whatever point is used, it is only necessary to slide frame *B* forward and frame *C* to the right, the distances named as shown on scale, to get range and azimuth for the gun in question. There is a pin *M* on end of range arm, which is held on spot located, the arm itself revolving around this pin as slide is moved to right or left, and sliding through arm slide *F*, which also revolves and actuates the azimuth pointer *E*.

The scale of board constructed is 100 yards to the inch, but any scale could be used.

It should be noted that the board can be installed in any station, and work of relocation done there, data being transmitted to the guns; or it could be used at gun position, and the only data necessary would be ranges and azimuths from the known points.

Owing to its simplicity, portability, and economy it is believed that this device is of value in our system of fire control. Possible errors due to expansion, contraction, and lost motion could be eliminated by using metal throughout its construction.

PROFESSIONAL NOTES

NOTES ON HIGH ANGLE FIRE*

By Harold C. Clausen, M. I. J. E.

I

The usual method of making up a high angle range table by calculating the trajectory in steps, or arcs, is a long and tedious one, and the results arrived at by this process have to be altered slightly, since at the angle of sight equal to nothing they do not generally agree with the ordinary range table along the ground. Therefore these results cannot be taken as quite accurate.

The method of utilizing the equations obtained when firing in a vacuum (parabola system), together with the ordinary range table along the ground, give results agreeing closely with those obtained by the step by step or small arc method, although it does not take account of the varying density of the air at different altitudes. Also, since a complete high angle range table on this system can be made out in a few days, which by the small arc method requires weeks, one may say that for practical purposes it will supercede the small arc method.

The deduction of the formulæ used in the parabola system are as follows:

Let V = Initial velocity.
" AP = Line of departure.
" AC = Range R along line of sight.
" ϵ = Angle of sight.
" α' = Tangent elevation necessary to give range AC at angle of sight E.
" ω^1 = Angle of impact made with line of sight.
" T_1 = Time taken to go from A to C when angle of sight = E.
" V_1 = Remaining velocity at C when angle of sight = E.
" θ = Angle of impact made with horizontal.
" α_0 = Tangent elevation for range AD = AC. Angle of sight = 0.
" ω_0 = Angle of impact when angle of sight = 0.
" T_0 = Time taken to go from A to D. Angle of sight = 0.
" V_0 = Remaining velocity at D. Angle of sight = 0.

With center A, and radius AC describe an arc cutting the horizontal at D, and the vertical at M. From C draw a line at right angles to AD cutting AD at B.

Considering the plane AC, the space described in time T, in a direction at right angles to it is zero.

The velocity and acceleration acting at right angles to the plane AC are V sin α' and g cos ϵ respectively, then,

---

* The term High Angle Fire is applied in the U. S. service to trajectories having angles of departure greater than 45° with the horizontal, and which terminate at or near the level of the gun. For the trajectories of anti-aircraft artillery the term High Fire has been used by the Coast Artillery Board.—*Editor.*

$$0 = V \sin \alpha' T_1 - \tfrac{1}{2} g \cos \epsilon T_1^2$$

$$\therefore T_1 = \frac{2V}{g} \; \frac{\sin \alpha'}{\cos \epsilon}$$

The horizontal velocity $V \cos(\epsilon + \alpha')$ remains constant throughout the flight. Therefore the distance $AB = V \cos(\epsilon + \alpha') T_1$.

$$\text{The range (R) } AC = \frac{AB}{\cos \epsilon} = \frac{V \cos(\epsilon + \alpha') T_1}{\cos \epsilon} \qquad \text{(1a)}$$

$$= \frac{2V^2 \cos(\epsilon + \alpha') \sin \alpha'}{g \cos^2 \epsilon} \qquad \text{(1b)}$$

When $\epsilon = 0$, α' is then called α_0

$$\text{and } R = \frac{V^2 \sin 2\alpha_0}{g}$$

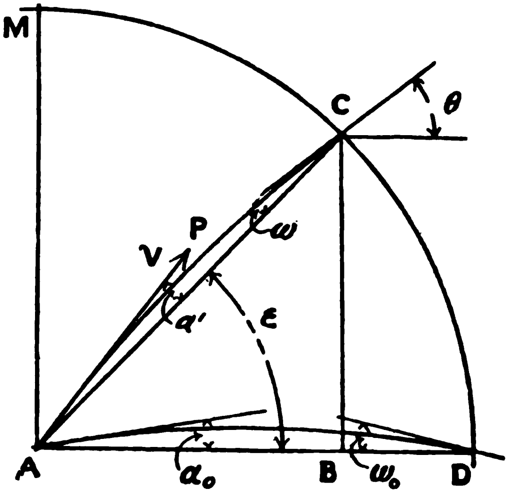


FIG. 1.

Substituting this value for R in (1b)

$$\text{we have } \sin 2\alpha_0 = \frac{2 \cos(\epsilon + \alpha') \sin \alpha'}{\cos^2 \epsilon} \qquad \text{(1c)}$$

from which α' can be found in terms of α_0 and ϵ. Keeping α_0 and the initial velocity V constant, α' can be found for various values of ϵ, all corresponding to the same range R along the line of sight.

Transforming (1c) we get

$$\sin 2\alpha_0 \cos^2 \epsilon = 2(\cos \epsilon \cos \alpha' - \sin \epsilon \sin \alpha') \sin \alpha'$$
$$= 2(\cos \epsilon \cos \alpha' \sin \alpha' - \sin \epsilon \sin^2 \alpha')$$

dividing by $\cos \epsilon \cos^2 \alpha'$ and remembering that $\cos^2 \alpha' = \dfrac{1}{1 + \tan^2 \alpha'}$ we find that:

$$(1 + \tan^2 \alpha')(\sin 2\alpha_0 \cos \epsilon) = 2 \tan \alpha' - 2 \tan \epsilon \tan^2 \alpha'$$

and that:

$$\tan^2 \alpha' (\sin 2\alpha_0 \cos \epsilon + 2 \tan \epsilon) - 2 \tan \alpha' + \sin 2\alpha_0 \cos \epsilon = 0$$

This is an equation of the second degree and solving, we get

$$\tan \alpha' = \frac{1 \pm \sqrt{1 - (\sin 2\alpha_0 \cos \epsilon + 2 \tan \epsilon) \sin 2\alpha_0 \cos \epsilon}}{\sin 2\alpha_0 \cos \epsilon + 2 \tan \epsilon} \qquad (1)$$

This formula was published in the Review "Mitteilungen über Gegenstände des Artillerie und Geniewesens" December, 1910, by an Austrian captain, J. Schmidt, who gave a general study of the Obermayer's principle. Also the above principle and formulæ formed the subject of an interesting article by Captain P. Prieto in the Review "Memorial de Artilleria" April, 1913.

Putting $\alpha_1 = \alpha_0$ in equation (1c) and transforming, leads to an equation of the fourth degree in ϵ. This equation and its solution is the basis of the Obermayer's principle.

The author has not seen any formulæ published connecting the time of flight, remaining velocity, and angles of impact for various angles of sight with the results of the above tangent elevation formula. In the article of the Review "Memorial de Artilleria" Gouin's graphic process was given for obtaining the remaining velocities and times of flight, but the author does not consider it as clear and as simple of application as the method given below:

We have from (1a) $T_1 = \frac{R}{V} \frac{\cos \epsilon}{\cos (\epsilon + \alpha')}$ (2a)

and when $\epsilon = 0$ $T_0 = \frac{R}{V} \frac{1}{\cos \alpha_0}$

$$\therefore \frac{T_1}{T_0} = \frac{\cos \epsilon \cos \alpha_0}{\cos (\epsilon + \alpha')}$$

$$\text{or } T_1 = T_0 \frac{\cos \epsilon \cos \alpha_0}{\cos (\epsilon + \alpha')} \qquad (2)$$

Also the remaining velocity v_1 can be expressed as a factor of v_0, thus:

The horizontal velocity at C $= v_1 \cos \theta$ (3a)
" " " " " $= V \cos (\epsilon + \alpha')$
and the vertical velocity at C $= v_1 \sin \theta$ (3b)
" " " " " $= V \sin (\epsilon + \alpha') - g T_1$

by squaring and adding we get

$$v_1^2 = V^2 - 2 V g T_1 \sin (\epsilon + \alpha') + g^2 T_1^2$$

substituting for T_1 from (2a) we have

$$v_1^2 = V^2 - 2 g R \frac{\cos \epsilon \sin (\epsilon + \alpha')}{\cos (\epsilon + \alpha')} + g^2 \frac{R^2}{V^2} \frac{\cos^2 \epsilon}{\cos^2 (\epsilon + \alpha')}$$

and since $R = \frac{V^2 \sin 2\alpha_0}{g}$

$$v_1^2 = Rg \left(\frac{1}{\sin 2\alpha_0} - 2 \cos \epsilon \tan (\epsilon + \alpha') + \frac{\sin 2\alpha_0 \cos^2 \epsilon}{\cos^2 (\epsilon + \alpha')} \right)$$

when $\epsilon = 0$ $v_0^2 = \frac{R g}{\sin 2\alpha_0}$

$$\therefore \frac{v^1}{v_0} = \sqrt{1 - 2 \cos \epsilon \tan (\epsilon + \alpha') \sin 2\alpha_0 + \left(\frac{\sin 2\alpha_0 \cos \epsilon}{\cos (\epsilon + \alpha')} \right)^2} \qquad (3)$$

Lastly, we will proceed to find the angle of impact. The angle of impact with the horizontal $= \theta$ is connected with the angle of impact with the line of sight $= \omega'$, by the relation:

$$\omega' = \epsilon - \theta \text{ or } \epsilon = \omega' + \theta$$

To find θ we have by dividing (3b) by (3a)

$$\tan \theta = \frac{V \sin (\epsilon + \alpha') - g T_1}{V \cos (\epsilon + \alpha')}$$

substituting for T_1 from (2a)

$$\tan \theta = V \sin (\epsilon + \alpha') - g \frac{R}{V} \frac{\cos \epsilon}{\cos (\epsilon + \alpha')}$$

and putting $R = \dfrac{V^2 \sin 2 \alpha_0}{g}$

$$\tan \theta = \tan (\epsilon + \alpha') - \frac{\sin 2 \alpha_0 \cos \epsilon}{\cos^2 (\epsilon + \alpha')} \qquad (4)$$

For firing in the air, the angle of impact made with the line of sight (ω_a) equals $\dfrac{\omega_0}{\alpha_0} \omega'$ approximately.

Table I gives the values of α', ω', $\dfrac{T_1}{T_0}$, and $\dfrac{V_1}{V_0}$, worked out for angles of sight equal to $-60°$, $-20°$, $20°$, $40°$, $60°$, and $80°$ for each of the following angles of $\alpha_0 = 1°, 3°, 6°, 10°$, and $15°$.

Figures 2 and 3 show these values plotted.

To illustrate the method of utilizing these results for a practical case of firing in the air, range table for 4.7-inch Q.F. gun published in the "Text Book of Gunnery," Part I, page 62, is used. First take the range, time of flight, remaining velocity, and angle of impact corresponding to say 6° elevation from this table, which are:

α_0	Range	Time	R.V.	Angle of Impact
6°	4925 yds.	11.2 secs.	949 f.s.	9° − 47′

Next find the tangent elevation, time of flight, remaining velocity, and angle of impact, for a range of 4925 yds. along line of sight and for an angle of sight of say 60°, by means of Table I.

From this table we get tangent elevation = 3° − 19′, angle of impact $\omega' = 4° - 9'$, then angle of impact in air

$$\omega_a = \frac{\omega_0}{\alpha_0} \omega' = \frac{9° - 47'}{6°} \times 4° - 9' = 6° - 46'$$

$$\frac{T_1}{T_0} = 1.107 \therefore \text{Time} = 1.107 \times T_0 = 1.107 \times 11.2 = 12.4 \text{ secs.}$$

$$\frac{V_1}{V_0} = .8 \therefore \text{R.V.} = .8 \times v_0 = .8 \times 949 = 759 \text{ f.s.}$$

In the same way values are arrived at for other angles of sight, and also for other ranges corresponding to 1°, 3°, and 10°.

Plotting these results, we can then read off tangent elevations, etc., for even ranges along line of sight.

On Figure 2 the curve $\alpha' = \alpha_0 \cos \epsilon$ known as the cosine rule is drawn for $\alpha_0 = 10°$ as a comparison with the results obtained above.

TABLE I.

ANGLE OF SIGHT. ε.

−60°				−20°				0°	20°				40°				60°				80°			
α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α_0	α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α'	ω'	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$
° ′	° ′			° ′	° ′				° ′	° ′			° ′	° ′			° ′	° ′			° ′	° ′		
0 30	0 29	.985	1.030	0 56	0 55	.994	1.012	1°	0 57	0 57	1.007	.988	0 47	0 47	1.012	.978	0 30	0 31	1.016	.97	0 11	0 11	1.019	.965
1 26	1 20	.956	1.085	2 46	2 41	.983	1.035	3°	2 53	2 58	1.019	.964	2 23	2 32	1.036	.93	1 34	1 45	1.051	.905	0 33	0 37	1.057	.891
2 47	2 20	.918	1.166	5 27	5 5	.966	1.069	6°	5 52	6 18	1.039	.926	4 57	5 46	1.077	.855	3 19	4 9	1.107	.800	1 10	1 31	1.125	.769
4 20	3 27	.873	1.262	8 50	7 59	.943	1.111	10°	10 3	11 30	1.076	.875	8 45	11 43	1.145	.748	6 3	9 30	1.213	.638	2 10	3 48	1.255	.571
6 6	4 27	.820	1.365	12 47	11 9	.915	1.159	15°	15 48	19 37	1.114	.811	14 43	25 13	1.281	.597	11 10	31 56	1.49	.367	4 34	40 22	1.771	123

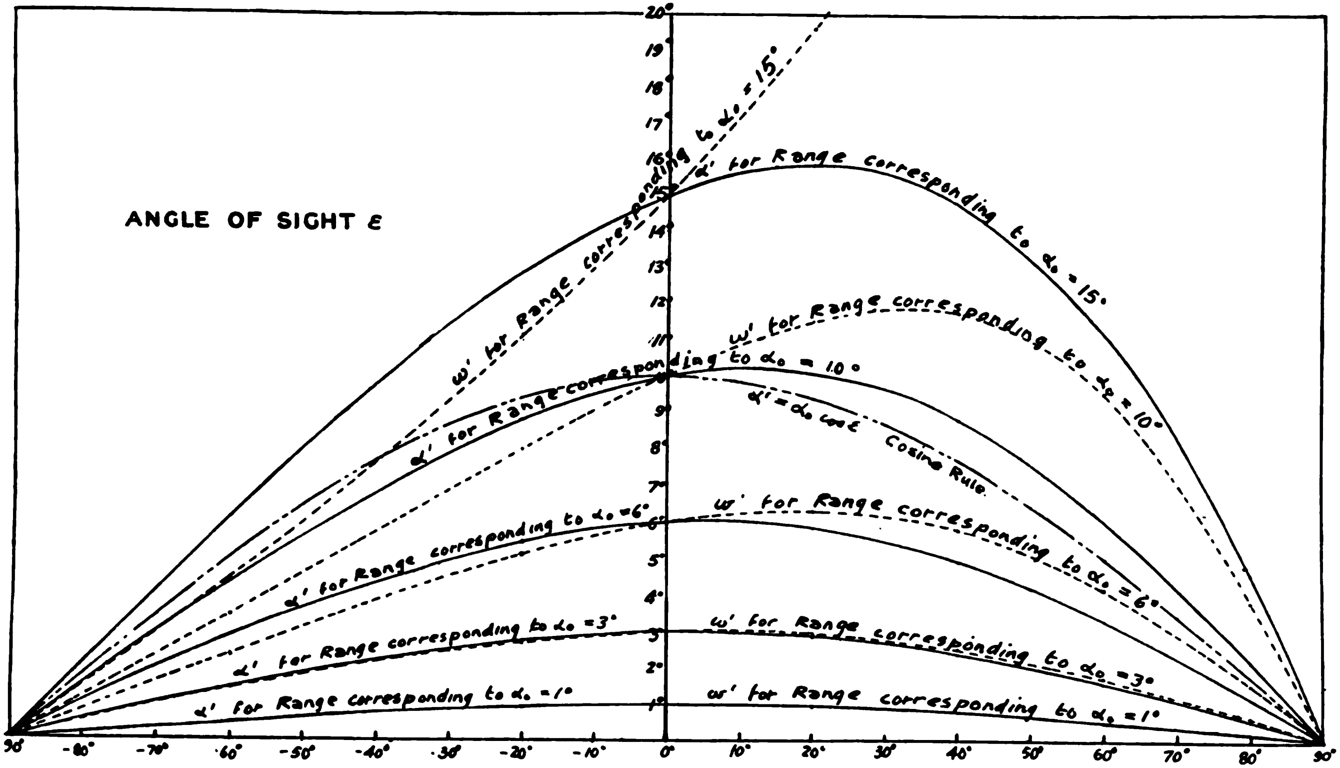

ANGLE OF SIGHT ε
α' for Range corresponding to α₀ = 15°
ω' for Range corresponding to α₀ = 15°
ω' for Range corresponding to α₀ = 10°
α' for Range corresponding to α₀ = 10°
α' = α₀ cos ε Cosine Rule.
ω' for Range corresponding to α₀ = 6°
α' for Range corresponding to α₀ = 6°
ω' for Range corresponding to α₀ = 3°
α' for Range corresponding to α₀ = 3°
ω' for Range corresponding to α₀ = 1°
α' for Range corresponding to α₀ = 1°
20°
19°
18°
17°
16°
15°
14°
13°
12°
11°
10°
9°
8°
7°
6°
5°
4°
3°
2°
1°
90°
-80°
-70°
-60°
-50°
-40°
-30°
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°

FIG. 2.

1936

TABLE I.

ANGLE OF SIGHT. ε.

−60°				−20°				0°	20°				40°				60°				80°			
α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α_0	α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$	α′	ω′	$\frac{T_1}{T_0}$	$\frac{V_1}{V_0}$
° ′	° ′			° ′	° ′				° ′	° ′			° ′	° ′			° ′	° ′			° ′	° ′		
0 30	0 29	.985	1.030	0 56	0 55	.994	1.012	1°	0 57	0 57	1.007	.988	0 47	0 47	1.012	.978	0 30	0 31	1.016	.97	0 11	0 11	1.010	.995
1 26	1 20	.956	1.085	2 46	2 41	.983	1.035	3°	2 53	2 58	1.019	.964	2 23	2 32	1.036	.93	1 31	1 45	1.051	.905	0 33	0 37	1.057	.891
2 47	2 20	.918	1.166	5 27	5 5	.966	1.069	6°	5 52	6 18	1.039	.926	4 57	5 46	1.077	.855	3 10	4 0	1.107	.800	1 10	1 31	1.125	.790
4 20	3 27	.873	1.262	8 50	7 59	.943	1.111	10°	10 3	11 30	1.076	.875	8 45	11 43	1.145	.748	6 3	9 30	1.213	.638	2 10	3 48	1.255	.571
6 6	4 27	.820	1.365	12 47	11 9	.915	1.159	15°	15 48	19 37	1.114	.811	14 43	25 13	1.281	.597	11 10	31 56	1.40	.307	4 34	10 22	1.771	123

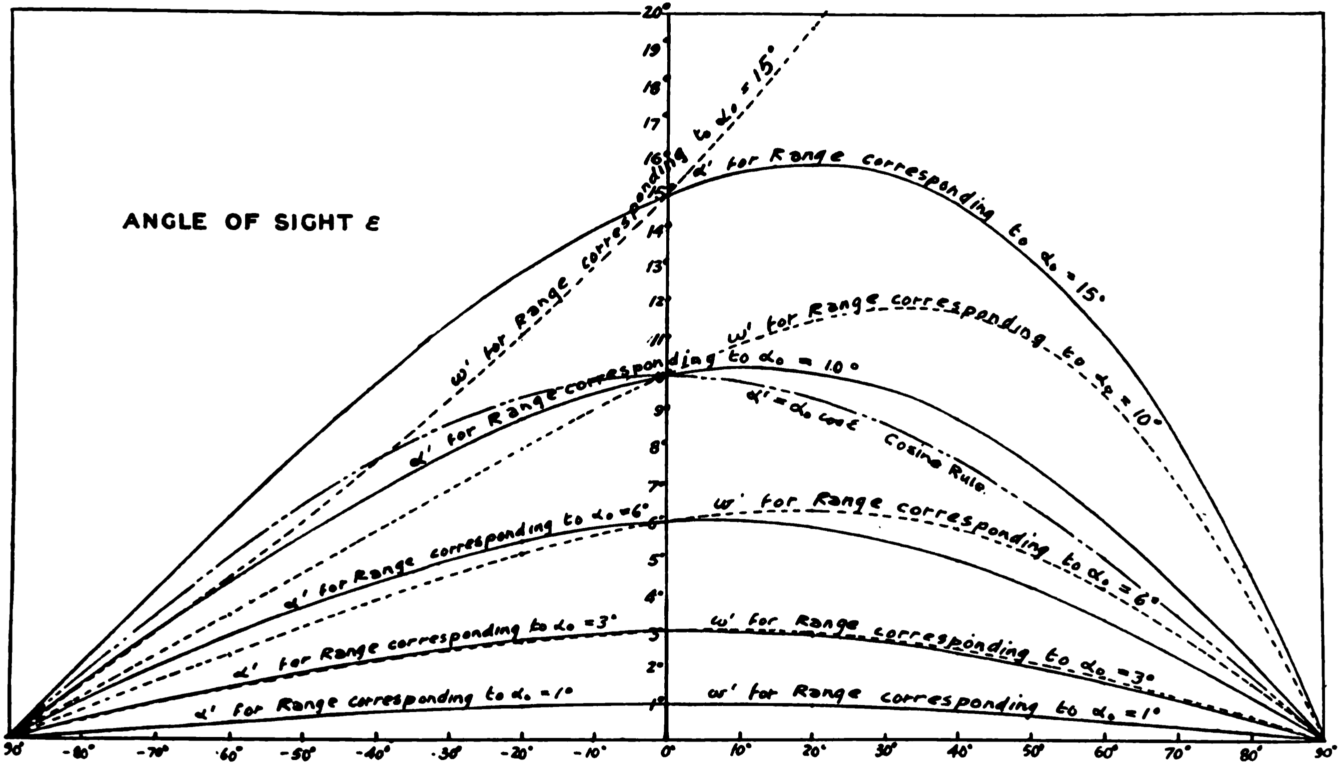

ANGLE OF SIGHT ε
α' for Range corresponding to $\alpha_0 = 15°$
ω' for Range corresponding to $\alpha_0 = 15°$
ω' for Range corresponding to $\alpha_0 = 10°$
α' for Range corresponding to $\alpha_0 = 10°$
$\alpha' = \alpha_0 \cos\varepsilon$ Cosine Rule.
ω' for Range corresponding to $\alpha_0 = 6°$
α' for Range corresponding to $\alpha_0 = 6°$
ω' for Range corresponding to $\alpha_0 = 3°$
α' for Range corresponding to $\alpha_0 = 3°$
ω' for Range corresponding to $\alpha_0 = 1°$
α' for Range corresponding to $\alpha_0 = 1°$
20° 19° 18° 17° 16° 15° 14° 13° 12° 11° 10° 9° 8° 7° 6° 5° 4° 3° 2° 1°
90° -80° -70° -60° -50° -40° -30° -20° -10° 0° 10° 20° 30° 40° 50° 60° 70° 80° 90°

FIG. 2.

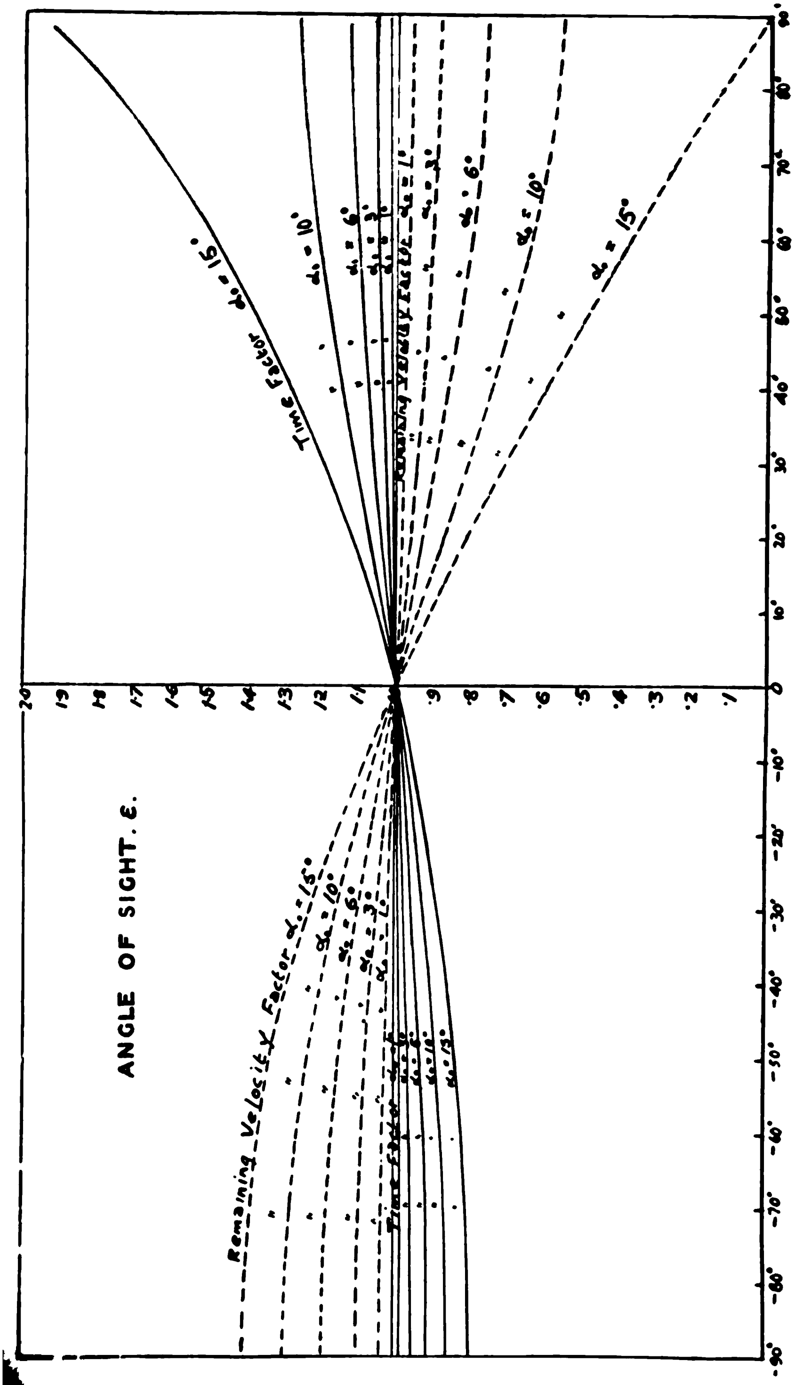

ANGLE OF SIGHT. ε.
Time Factor α₀ = 15°
α₀ = 10°
α₀ = 6°
α₀ = 3°
α₀ = 1°
Remaining Velocity Factor α₀ = 1°
α₀ = 3°
α₀ = 6°
α₀ = 10°
α₀ = 15°
Remaining Velocity Factor α₀ = 15°
α₀ = 10°
α₀ = 6°
α₀ = 3°
α₀ = 1°
Time Factor α₀ = 1°
α₀ = 3°
α₀ = 6°
α₀ = 10°
α₀ = 15°
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
90°
80°
70°
60°
50°
40°
30°
20°
10°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°
1911

Fig. 3.

II

This part of the article deals with the maximum height attained when firing vertically in the air. Heights and corresponding times of flight are calculated in two parts, the first part from the initial velocity to a velocity of 1000 f.s., the second from a velocity of 1000 f.s. to a velocity equal to nothing.

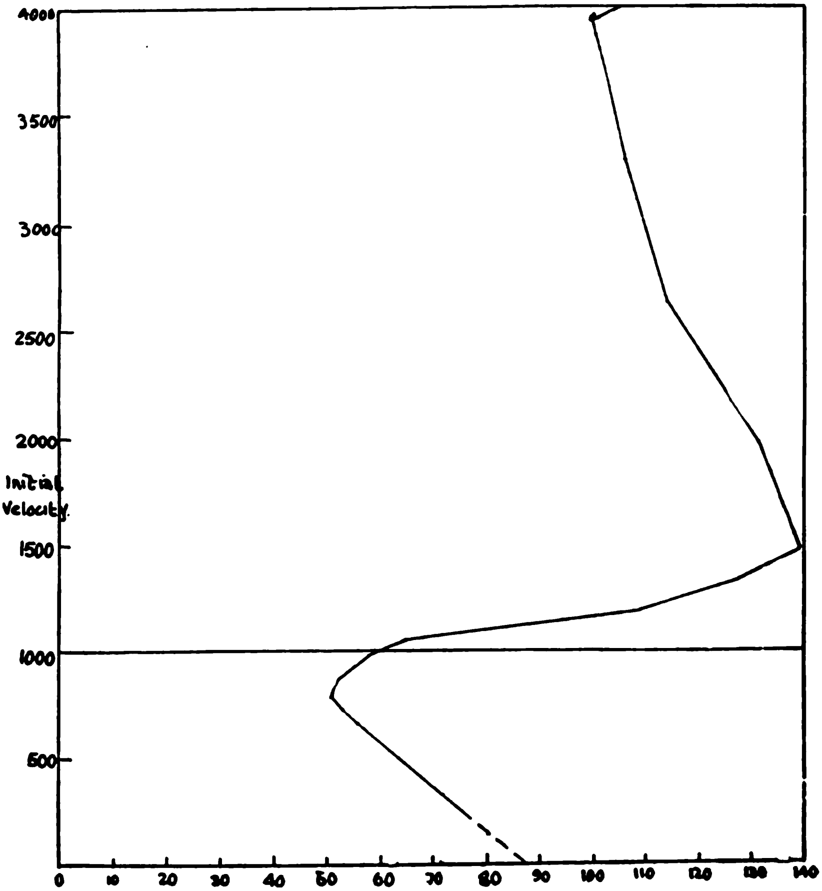


Fig. 4.

The resistance of the air to a one-inch projectile is assumed to follow the law

$$p = \frac{k}{g}\left(\frac{v}{1000}\right)^2$$

and the value of k is taken from the new table figures of p published by Captain J. H. Hardcastle in an article on "New Experiments on Air Resistance" which appeared in *Arms and Explosives* and also in the JOURNAL OF THE UNITED STATES ARTILLERY, September-October, 1913.

The value of k is plotted as abcissa, and the corresponding velocity as ordinate, as shown in Figure 4. The mean value of k from the initial velocity to a velocity of 1000 f.s., and from a velocity of 1000 f.s. to a velocity equal to nothing, is found from the curve.

Initial velocity to 1000 f.s.		Mean value of k	
3500 f.s.	"	118	Part I.
3000 "	"	121.5	
2750 "	"	123	
2500 "	"	125	
2250 "	"	124	
2000 "	"	121	
1750 "	"	116	
1500 "	"	106	
1000 to 0		65	Part II.

These values are used in the following equations to find the height, and time.

Considering retardation r due to air resistance alone, leaving out, for the moment, the effect of gravity, we have from the laws of motion that force = mass by retardation

$$\therefore r = \frac{F}{m} = \frac{(pd^2)g}{w} = \frac{pg}{C} \text{ where } \frac{w}{d^2} = C$$

and from (1)

$$r = \frac{k}{C}\left(\frac{v}{1000}\right)^2 = \sigma\left(\frac{v}{1000}\right)^2 \text{ where } \sigma = \frac{k}{C}$$

The retardation vertically upwards, taking gravity into account, is expressed by

$$\frac{dv}{dt} = -g - r = -(g+r) \tag{2a}$$

$$\therefore t = -\int_{v_1}^{v_2}\frac{dv}{g+r} = -\int_{v^1}^{v^2}\frac{dv}{g+\sigma\left(\frac{v}{1000}\right)^2}$$

$$= -\frac{1000}{\sqrt{g\sigma}}\left[\tan^{-1}\frac{v}{1000}\sqrt{\frac{\sigma}{g}}\right]_{v_1}^{v_2} \tag{2}$$

$$\text{for Part I } t_1 = \frac{1000}{\sqrt{g\sigma_1}}\left\{\tan^{-1}\frac{v_1}{1000}\sqrt{\frac{\sigma_1}{g}} - \tan^{-1}\sqrt{\frac{\sigma_1}{g}}\right\}$$

$$\text{for Part II } t_2 = \frac{1000}{\sqrt{g\sigma_2}}\tan^{-1}\sqrt{\frac{\sigma_2}{g}}$$

Space described in time dt is expressed by

$$dy = v\,dt = -\frac{v\,dt}{g+r} \text{ from (2a)}$$

$$\therefore y = -\int_{v_1}^{v^2}\frac{v\,dv}{g+r} = -\int_{v_1}^{v_2}\frac{v\,dv}{g+\sigma\left(\frac{v}{1000}\right)^2}$$

$$y = \frac{1000^2}{2\sigma}\left[\log\left\{g+\sigma\left(\frac{v}{1000}\right)^2\right\}\right]_{v_1}^{v_2}$$

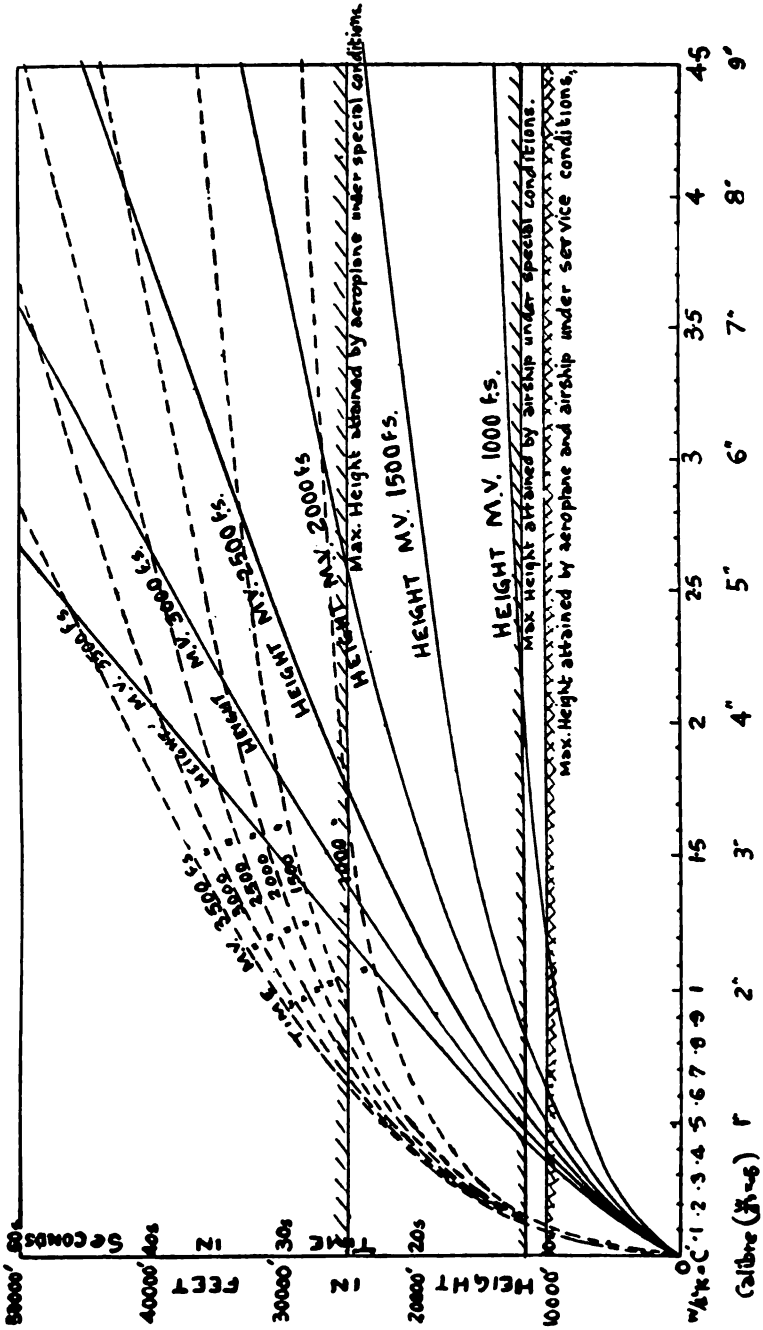
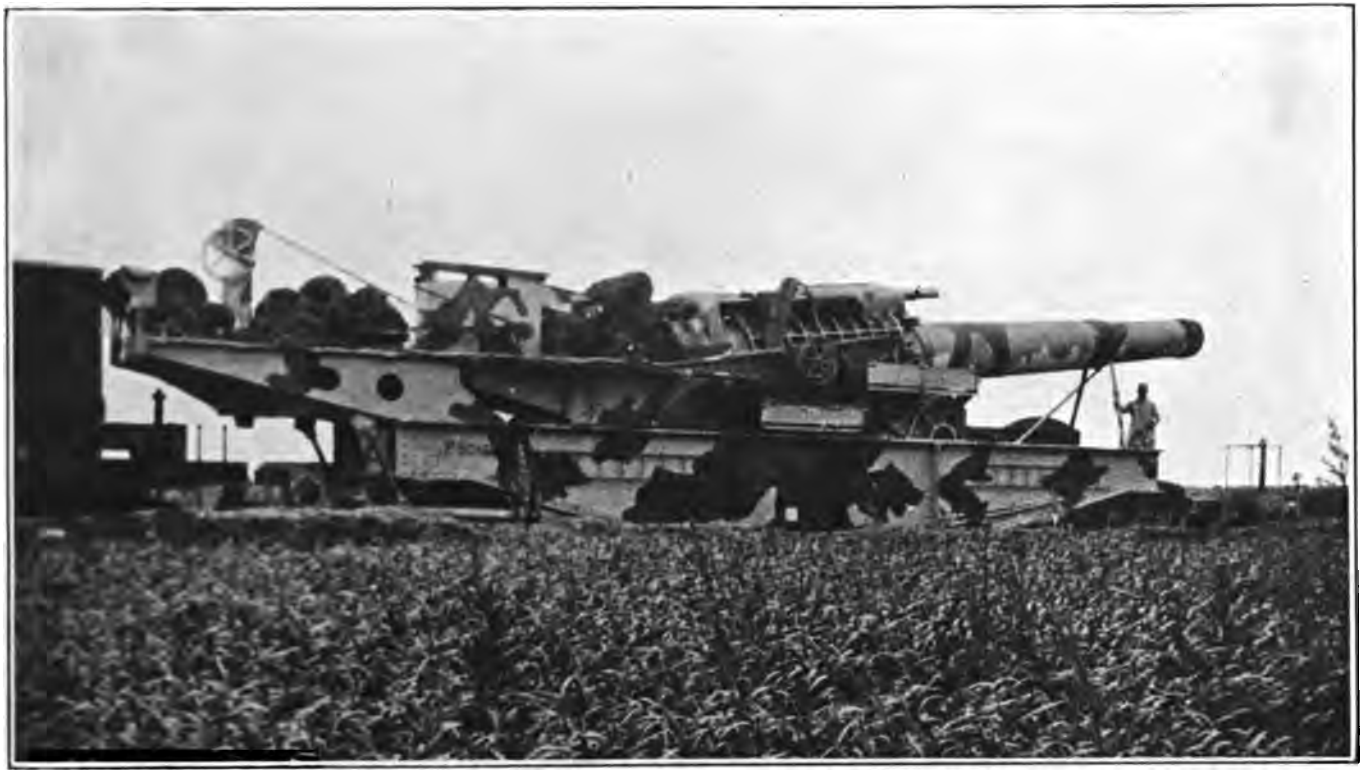

50000'
40000'
30000'
20000'
10000'
0
HEIGHT IN FEET
80s
40s
30s
20s
TIME IN SECONDS
W/K²C
Calibre (W/K = ·6)
·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8 ·9 1 1·5 2 2·5 3 3·5 4 4·5
1" 2" 3" 4" 5" 6" 7" 8" 9"
TIME, M.V. 3500 f.s.
3000 "
2500 "
2000 "
1500 "
1000 "
HEIGHT, M.V. 3500 f.s.
HEIGHT M.V. 3000 f.s.
HEIGHT M.V. 2500 f.s.
HEIGHT M.V. 2000 f.s.
HEIGHT M.V. 1500 f.s.
HEIGHT M.V. 1000 f.s.
Max. Height attained by aeroplane under special conditions.
Max. Height attained by airship under special conditions.
Max. Height attained by aeroplane and airship under service conditions.

FIG. 5.

velo
ity



Photograph by American Press Association.

1930

A Heavy French Field Gun Called by the Soldiers "The Humming Bird"

TRAJECTORIES OF PROJECTILES DISCHARGED AT AN ELEVATION OF 45 DEGREES

Many months have elapsed since the newspapers mentioned a bombardment of Dunkerque by a German gun at a range of more than 20 miles. Very little, if anything, has been heard of that gun since. The news, however, induced M. de Sparre to address several communications, in December, 1915, and in January and April last, to the Paris Academy on the trajectories of projectiles discharged with high velocities at elevations of about 45 deg. He points out that projectiles would under these conditions rapidly enter layers of an atmosphere of very much reduced density, and he calculates the trajectories on the basis of the formulæ of Charbonnier and of Siacci, which he extends for his purpose. Assuming that the gun has a caliber of 381 mm. and that the projectile weighs 720 kg., and accepting the figures for normal German ordnance as given by Cranz and others, including the ballistic index 0.865, he calculates that the high elevation of 45 deg. increases the range by from 35 to 40 per cent and by about 10 km. in this instance. The velocity of the projectile would pass through a minimum after the shell had reached its summit, and then increase to a maximum, finally to decrease again. In his last communication he considers that the index 0.865 is probably too high, and he recalculates his data for a ballistic index of 0.75. The velocities he arrives at for different parts of the curved trajectory are: 940, 592, 443, 386, 394, 437, 433 m. per second, these figures corresponding to curvatures (in round figures) of +45 deg., 36¼ deg., 20¾ deg., 0 deg., −25 deg., −45½ deg., −58 deg. He also makes calculations for another gun of 406.4 mm. discharging shells of 920 kg. weight; in this case he deduces a maximum range of 40 km. Finally he inquires into the influences of temperature and barometric pressure. Those influences would be exceedingly strong, both a fall of temperature and a rise of the barometer tending to shorten the maximum range very considerably. In comparison tables he gives the results of calculations made for an atmosphere of constant density.—*Engineering.*

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APPROXIMATE ESTIMATIONS OF THE RANGE AND ALTITUDE OF AIRCRAFT

Today the great topic of conversation, and the prime subject of newspaper comment, is the Zeppelin. When the Zeppelin does come the lay expert is full of information. He tells us in awe-struck whispers of the mighty powers of the ghost-like airship caught in the streams of the searchlights, and of the wonders of the shells that glide across the sky and burst around their target. And then he volunteers figures of ranges and heights which always lead to long argument.

Issues of the *Times* some time back contained articles and correspondence on the all-pervading subject. Of special interest and worth were the views of M. Georgef Prade, who, when he ventured on the delicate ground of ranges and heights, was taken to task by Professor Rambant, of Oxford. Accepting as his basis of calculation that a Zeppelin is 520 feet in length, M. Prade declared that at a height of 9750 feet an airship of the size mentioned would appear "barely half the apparent diameter of the moon." Professor Rambant's letter pointed out the error of this statement, declaring that the angular measurement of the semi-diameter of the moon was about 15½ minutes, and that a Zeppelin 520 feet long, "if vertically overhead at a height of 7500 feet, would subtend an angle of more than three degrees, and would therefore appear about twelve times as large as the above comparison would suggest."

Given a telemeter or graticuled glasses the distance of a Zeppelin is more or less readily determined. But it is not likely that many observers would be provided at the critical moment with such instruments. Rough and ready means must, accordingly, be adopted, though calculation errors running into an odd mile or more are certainly unnecessary even in the absence of accurate observing instruments. All that is required for a rough distance-judging device is a foot-rule, or something even smaller—a rule three or four inches in length marked in eighths of an inch.

A small rule of this sort should be held at arm's length, straight out in front of the body, and in line with the eye. The rule should be grasped between the half-clenched fingers of the right-hand, so that the thumb can be moved readily along the scale as an index. The distance of the rule from the eye so held will be found to measure, approximately, 25 inches.

Within certain limits reasonably accurate measurements of a Zeppelin's range and height can be effected by means of a contrivance of this nature. Assuming first of all that the Zeppelin is broadside on the observer may find that by moving the thumb-index on the rule held at a distance r (= 25 inches) from the eye the objective apparently measures h inches. Putting H for the length of the Zeppelin and R the range along the line of sight to the Zeppelin, the following relation results:

$$h : r :: H : R \qquad (1)$$

On the assumption that a Zeppelin has a known length of, say, 520 feet,[1] the realtion (1) supplies for any length of r a corresponding R. By transposing

$$\mathrm{R} = \frac{Hr}{h} \qquad (2)$$

and, replacing symbols by figures,

$$R = \frac{520 \times 25}{h} = \frac{13{,}000}{h} \qquad (3)$$

from which to obtain the range along the line of sight in *feet;* or

$$R = \frac{2.462}{n} \qquad (4)$$

for the range along the line of sight in *miles*. The angular measurement, (A) in minutes, which the object subtends at the eye, is given by:—

$$A = \frac{h}{r \times 0.00029} \qquad (5)$$

or, keeping h and r in inches, as before;

$$A = \frac{h}{25 \times 0.00029} \qquad (6)$$

---

[1] On the authority of Lord Montagu the length of the newer Zeppelins is about 600 feet.

By formulæ (6), (3), and (4) it is easy to construct a table such as the one * * * [below] for various values of *h*, the measurement of the thumb-index on the rule. The column of angular measurements is useful for comparing with the apparent diameter of the moon. The size of our satellite is familiar to all, but the Zeppelin raider will avoid giving the opportunity of making direct comparisons. The table shows that when a 520-foot Zeppelin is at a range of 9450 feet it subtends an angle of 190 minutes, little more than 3 degrees, or about six times that subtended the diameter of the moon, at her mean distance, in consonance with Doctor Rambant's statement quoted previously. Whilst waiting for a Zeppelin appearance, the moon at about the full is a useful object to practice on for distance judging.

TABLE I

Length on rule	Angular measurement	Range of Zeppelin	
		In feet	In miles
inch	minutes		
¼	34	52,000	9¾
⅜	52	34,700	6½
½	69	26,000	5
⅝	86	20,800	4
¾	103	17,350	3¼
⅞	121	14,850	2¾
1	138	13,000	2½
1⅛	155	11,550	2½
1¼	172	10,400	2
1⅜	190	9,450	1.8
1½	207	8,650	1.6
1⅝	224	8,000	1.5
1¾	241	7,450	1.4
1⅞	258	6,950	1.3
2	276	6,500	1.2

The distance along the line of sight to the Zeppelin having been ascertained, a fair estimation of its vertical height above the ground and its range on the horizontal is also possible. In the absence of any more accurate means of determination, such as a sextant, this necessitates a guess at the angle of sight. A little practice will permit the angle to be guessed within 5 or 10 degrees. Obviously the vertical height above the ground and the range in the horizontal are given by multiplying *R* by the sine and the cosine of the angle of sight respectively. These trigonometrical functions can be expressed conveniently by fractions, and the desired height and range may be obtained by using the factors contained in the following table:—

As an example for the use of Tables I and II, a Zeppelin broadside-on may be assumed to subtend a measurement of ⅞-inch on the rule held at arm's-length from the eye. Table I supplies as the range 14,850 feet, or 2¾ miles. The angle of sight is estimated to be 40 degrees; so that the vertical height of the Zeppelin is 14,850×7/11 = 9440 feet, or 2¾×7/11 =

1¾ miles. Using Table II again, the range on the horizontal becomes 14,850 ×¾ = 11,130 feet, or 2¾×¾ = 2 miles.

TABLE II

Angle of sight	Fraction with which to multiply columns 3 or 4 of Table I in order to ascertain	
	Vertical height of Zeppelin	Range in horizontal to Zeppelin
degs.		
10	1/6	60/61
20	1/3	15/16
30	1/2	6/7
40	7/11	3/4
45	7/10	7/10
50	3/4	7/11
60	6/7	1/2
70	15/16	1/3
80	60/61	1/6

When the Zeppelin is not broadside-on the estimation is complicated by the necessity to allow for the fore-shortening effect. The number of considerations which have to be weighed in this connection will prevent at the moment the detailed analysis which is necessary for the framing of approximate general rules. The simple calculations upon which the tables presented above have been based have perhaps been expounded at tedious length, but the excuse must be that estimations based on absence of method are apt to go widely astray of the truth. Rough and ready methods are sufficiently accurate for all ordinary purposes provided the measurements made are correctly handled afterwards.

Coin	Diameter of coin	Range of Zeppelin
	inch	miles
Threepence	⅝	4
Sixpence or Half-Sovereign	¾	3¼
Sovereign	⅞	2⅞
Halfpenny	1	2½
Half-Crown	1¼	2
Crown	1½	1.6
A Penny and a Farthing alongside	2	1.2

Memo.—The above article was already in type when the writer remembered a useful little table which appears in Sir George Greenhill's monumental work, *Notes on Dynamics*, and thence the idea occurred to use our coinage instead of the rule as described above for the purposes of measurement. Sir George points out that the Imperial coinage is designed to serve as a ready standard of measure. Instead of the "Length on rule" in Table I being used, the alternative suggests itself of estimating the range of the Zeppelin by ascertaining which coin the airship subtends when the coin is held at arm's-length. The alternative suggestion is apparentfrom the table on bottom of page 369.

The last line of the table gives a hint as to what may be effected, by a combination of coins, for obtaining almost any measurement.

—*Arms and Explosives.*

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TWO YEARS OF AERIAL WAR

By Claude Grahame-White and Harry Harper

(The author's limit their remarks to the aeroplanes.—Ed.)

When the war broke out in 1914, the aeroplane had had no service record. Both fliers and machines were without war experience, and it was predicted by some that in a week, such machines as had escaped artillery fire would be worn-out, and aviators themselves would be nervous wrecks.

But this prediction was falsified from the start. In spite of the fact that air fleets were inadequate, organization and equipment experimental, and aviators without experience, the flying service, in the very earliest phase of the war, had a far-reaching effect on the campaign. First there was strategical scouting, gaining news of the enemy's disposition which it would have been impossible to get in any other way. On Aug. 23, 1914, at Mons, the flying corps confirmed the news of the arrival of German masses seeking to envelop the British. On the other side, the German learned from their own service that the French offensives in Alsace and Lorraine lacked the strength in men to push them home.

The armies once in contact, the value of air-control of artillery fire immediately revealed itself. The Germans were the first to employ this method, and so thorough was their work, so helpless the [British] artillery to make any return that aeroplanes had to be sent up to drive away the enemy observers. Here the British had an advantage, thanks to their speedier machines and to the skill and daring of their aviators. The German idea had been to build a machine that would make the least possible demand upon the skill and endurance of the pilot; this idea was good, and the machines themselves were admirable. But these qualities had been obtained at the expense of speed and rapidity of maneuver; hence the Allies, and particularly the French, content with a lower factor of safety, and less concerned with inherent stability, provided themselves with speedier machines, more quickly maneuvered, than those of the Germans.

The point is that in war machines unnecessarily high factors of safety mean less speed and ascensional power for any given horse-power, than would be the case with machines built more lightly. Under normal (peace) conditions these factors are necessary. A war pilot must feel, however, not that his machine is safe under abnormal stress unlikely to occur, but that when engaged he can fly at least as fast as his adversary. Efficiency must not give way to safety; both war and flying are essentially perilous, anyway.

It had been supposed that a need existed of military aeroplanes of exceptional strength, able to survive the rough handling of war. But experience soon showed that it was undesirable to have machines of this character; their weight, other things equal, was too great. Moreover, there is no such thing as satisfactory housing for aeroplanes, and no country had enough skilled men to keep at the front a force to undertake the repair of machines in use. Hence it was found more expeditious, and in the long run cheaper, to scrap aeroplanes and obtain new ones. If an aeroplane could survive, say two months of war, that was sufficient. For another reason, it is unnecessary to build machines to last a long time, because before they wear out, they will have been made obsolete by better ones.

It should not be assumed that the German military machines failed of their purpose. They had been built for long no-stop flights, and this purpose they fulfilled admirably. No one could tell in advance that they would prove less suitable for aerial fighting than Allied aircraft: indeed no one had foreseen that aerial fighting would prove so important. It was argued that hostile air scouts would avoid one another more or less, so that air combats took both sides somewhat by surprise. The determination of pilots, when range-finding for their artillery, had not been anticipated, and no one imagined that huge armies would lie facing each other month after month, with aircraft in daily conflict. This situation developed a general routine of war flying. Daily surveys were made of enemy positions, to detect his batteries and to observe his movements. Flights far beyond his front lines were needed to "spot" any shifts of reserves, to locate ammunition depots, to watch railway centers. Photography from the air was greatly improved, and wireless telegraphy developed, mainly to assure quick and accurate co-operation between the airman above and the gunner below.

It was then that aerial fighting grew in frequency from day to day, and the Germans, at a disadvantage at first because of their slower machines, were quick to make use of their high-powered engines, and of their successful adaptation of racing motor-car engines to purposes of flight. They built large fighting biplanes, able, even when carrying a pilot and two passengers, each of whom worked a machine gun, to fly fast and to climb fast. These machines were largely employed to patrol the air above their own lines, seeking to check the penetration of enemy scouts, or to attack hostile machines engaged upon range-finding.

They cruised usually at high altitudes, swooping down on enemy machines which were on reconnaissance, and so compelled to fly lower. The difference should be noted here between a scouting machine and a fighting machine. So far it has been found impossible to design an aeroplane that shall be ideal in more than one particular. It may fly fast, it may be very stable, it may carry heavy loads, it may be excellent for observation. But it cannot be all these things at one and the same time.

The Allies suffered losses through the operation of defensive craft employed by the Germans to oppose reconnaissance, and also because of their use of small, high-speed, single seaters, in which the pilot also worked a machine gun. These monoplanes climbed high and they would dive over some enemy scout, go by behind him and pour a stream of bullets into his machine. It should be remarked, however, that this form of aerial duelling was originated by the Allies.

The Germans operated chiefly on the defensive: apparently they reached no such high average of scouting flights, made from day to day and under varying conditions, as did the British. This was because they no sooner

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or for combat. Speed alone, however, is not sufficient. There is no
outmaneuvering and outsailing an antagonist unless he can be put
business or brought down. The effect of machine guns is uncertain.
is needed is a weapon specially designed for the conditions of aerial
k: a quick-firing weapon, light, powerful, and using small explosive
. The ideal projectile in its turn, must be fuzed so sensitively that it
detonate on striking an aeroplane wing, and yet resist the shock of dis-
ge, and the pressure of swift passage through the air. The fighting
plane, which will increase in importance with time, presents a problem
omplexity. It must raise loads, and yet weight counts. It must make
g no-stop flights but must not lose speed or capacity for rapid climbing
l maneuvering, else it may be helpless at the moment of combat. It is
sible that results may be obtained by using lifting planes. Design must
such as to reduce air resistance, and engines of many thousand horse-
wer must yield a maximum of power with a minimum of weight, transmit
is power efficiently to the propellers, and at the same time be reliable. * * *

—From *The Fortnightly Review* in *The International Military Digest.*

◆ ◆ ◆

A GUN THAT SHOOTS BOTH WAYS AT ONCE

The principal factors that limit the power of armament for use on aircraft are the force of recoil and the weight of the gun. If the former is too severe the plane will suffer violent and highly dangerous perturbations at each discharge; if the latter is too great, mobility is seriously impaired.

To overcome these limitations, an American firm has finally brought to perfection an entirely novel and very ingenious type of gun. The original conception contemplated a gun so installed that on firing it was free to fly to the rear under the reaction developed when the projectile was discharged to the front. The gun was of course lost after each shot. A further development of the idea resulted in a double length gun containing two projectiles driven, the one toward the target and the other at random to the rear, by a single powder charge placed in the center of the gun. In effect the device was two guns, of equal bore and equal powder pressure, placed breech to breech so that the recoil of each was just sufficient to take up that of the other. In the absence of any surfaces upon which there could be an uncompensated working of the longitudinal drive from either gun, the result was complete balance of forces.

With the development of this invention the greatest obstacle to large size aeroplane guns has been overcome; but there remains a certain limitation in weight. This, too, though not entirely eliminated, is greatly reduced. The very absence of recoil cylinders effects a considerable saving in weight; and at the same time the gun itself can be made as light as is consistent with strength, without thought of resulting increase in the violence of recoil, or of weakening the gun's resistance to the longitudinal stresses arising from checking the recoil. This permits the use of an exceptionally light grade of special alloy steel, of such high quality and homogeneity that it may be subjected to much higher fiber stress than steel is ordinarily expected to withstand, with a much larger factor of safety than is usual in ordnance work.

We may supplement this general discussion of principles by a statement of some of the details of construction. The gun is cast as two separate

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eight of 5000 feet, is 6000 yards, three times its effective range at the earth's urface.

The practicability and effectiveness of this gun have been amply demonstrated in practice. Freed from the heavy pitching which the recoil of the ordinary gun produces, or from the excessive weight of the older types of recoil absorbers, an aeroplane equipped with it has a vastly increased freedom of action. It may fly higher and farther and faster, it may carry a greatly increased supply of ammunition, it may fire much more frequently and at the same time with equal or greater accuracy, than ever before. And it is to be remembered that the use of this novel gun is by no means limited to aircraft. It will now be possible to mount artillery of relatively large caliber upon torpedo vessels and upon motor boats and motor vehicles of every description. Indeed, so far as the science of making war has yet progressed, this gun represents the ideal type of ordnance for use on small units of any nature where extreme mobility and ease of transportation are the important considerations.—*Scientific American.*

◆ ◆ ◆

THE *EMDEN-SYDNEY* ENGAGEMENT

BRIEF DESCRIPTIONS OF "EMDEN" AND "SYDNEY"

"EMDEN"

Built at Danzig. Commissioned, Fall of 1908.
Authorized, 1906. Laid down, June, 1906. Launched, May 26, 1908.
Length, 386.6 feet. Beam, 44.3 feet. Draught (mean), 15.8 feet.
Displacement, 3592 tons.
I. H. P., 16,168, equals 24.1 knots.
Coal capacity, 393 to 836 tons.
Engines, two sets triple expansion reciprocating.
Boilers, 12 Schultz.
Armor, deck, 2 inches to .8 inch. Conning tower, 3.9 inches.
Armament, 10 4.1-inch (40 caliber); 2 machine guns. Torpedo tubes, 2 18-inch submerged on broadside.
Complement, 361.

"SYDNEY"

Built at Govan.
Laid down, April 14, 1911. Launched, May 30, 1912.
Length, 456.5 feet. Beam, 49.8 feet. Draught (mean), 15.7 feet.
Displacement, 5400 tons.
I. H. P., 22,000, equals 24.7 knots.
Fuel capacity, coal, 650 to 1000 tons; fuel oil, 250 tons.
Engines, 4 shafts, Parsons turbines. Boilers, Yarrow.
Armor, belt, 3 inches; deck, 1 inch.
Armament, 8 6-inch (50-caliber); 4 3-pdr.; 4 machine guns. Torpedo tubes, 2 21-inch submerged on broadside.
Complement, 376.

THE ENGAGEMENT

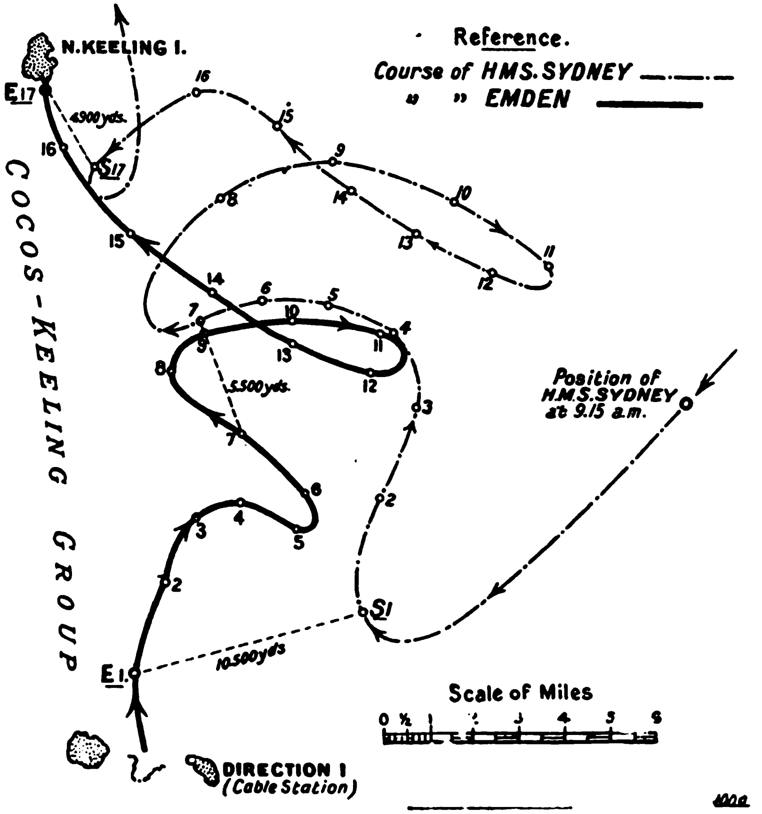
Extracts from a letter written by an English naval officer aboard H.M.S. *Sydney*, describing this engagement, taken from the *London Times* of December 15, 1914.

[illegible]

[illegible] was

unwounded, but badly shaken. However, he pulled himself together when I spoke to him, and told him I wanted him to do what he could for the wounded. I then ran back to my group.

"All the time we were going 25 and sometimes as much as 26 knots. We had the speed on the *Emden* and fought as suited ourselves. We next changed around to starboard guns and I then found the gunlayer of No. 1 starboard had been knocked out close to the conning tower, so I brought Atkins over to fire No. 1 starboard. I was quite deaf by now, as in the hurry there had been no thought of getting cotton wool. This is a point I won't overlook next time.



THE NUMBERS IN THE ABOVE DIAGRAM INDICATE THE RESPECTIVE POSITIONS OF H. M. S. "SYDNEY" 1032 AND OF THE "EMDEN" AT VARIOUS STAGES OF THE DECISIVE ACTION ON NOVEMBER 9.

KEY: H. M. S. "SYDNEY"
1– 7 PORT BATTERY.
8–11 STARBOARD BATTERY.
12–16 PORT BATTERY.
17 STARBOARD BATTERY.

THEREUPON "CEASED FIRE," AND STEERED N. IN PURSUIT OF THE "EMDEN'S" COLLIER.

"Coming aft the port side from the forecastle gun I was met by a lot of men cheering and waving their caps. I said, 'What's happened?' 'She's gone, Sir, she's gone.' I ran to the ship's side, and no sign of a ship could I see. If one could have seen a dark cloud of smoke, it would have been different. But I could see no sign of anything. So called out, "All hands

"On Noven
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I went away, but presently he came up to me and said, 'Thank you much for saying that, but I was not satisfied. We should have done r. You were very lucky in shooting away all my voice-pipes at the nning.'

"When I got a chance, with all the boats away, I went to have a look nd the ship. I have no intention of describing what I saw. With the eption of the forecastle, which is hardly touched from fore-bridge to n post, she is nothing but a shambles, and the whole thing was most cking. The German doctor asked me to signal for some morphia, sent aft, and I never came forward again.

"Of the German officers, Witthoef, the torpedo lieutenant, was a oroughly nice fellow. Lieutenant Schal was also a good fellow, and half nglish. It quite shook them when they found out that the captain had sked that there be no cheering on entering Colombo, but we certainly did not want cheering with rows of badly wounded men laid out in cots on the quarter deck. Captain von Muller is a very fine fellow.

"At Colombo we dropped all our wounded cargo, English and German. From the number of men we rescued, *i. e.*, 150, we have been able to reckon their losses. We know the number of men who landed at Cocos and got away, and the number of the prize crew in the collier. They cannot have lost less than 180 men killed, with 20 men badly wounded and about the same number slightly.

"There are lots of redeeming points in the whole show. Best of all was to see the gun's crew fighting their guns quite unconcerned. When we were last in Sydney we took on board three boys from the training ship *Tingira*, who had volunteered. The captain said, 'I don't really want them, but as they are keen, I'll take them.' Now the action was only a week or two afterwards, but the two of the three who were directly under my notice were perfectly splendid. One little slip of a boy did not turn a hair, and worked splendidly. The other boy, a very sturdy youngster, carried projectiles from the hoist to his gun throughout the action without so much as thinking of cover. I do think for two boys absolutely new to their work they were splendid.

"It was very interesting talking to some of the German officers afterwards. On the first day they were on board one said to me, 'You fire on the white flag.' I at once took the matter up, and the torpedo lieutenant and an engineer both said emphatically, 'No, that is not so, you did not fire on the white flag.' But we did not leave it at that. One of us went to the captain, and he got from Captain von Muller an assurance that we had done nothing of the kind, and that he intended to assemble his officers and tell them so.

"The day Captain von Muller was leaving the ship at Colombo, he came up to me on the quarter deck wounded, shook hands and saluted, which was very nice and polite of him. I think, acting under their rules, he and his crew refused to give parole after their arrival at Colombo, but he conscientiously observed it while in the *Sydney*, which was more like a hospital ship than a man-of-war, while running to Colombo. Prince Hohenzollern was a decent enough fellow. In fact, we seemed to agree that it was our job to knock one another out, but there was no malice in it."

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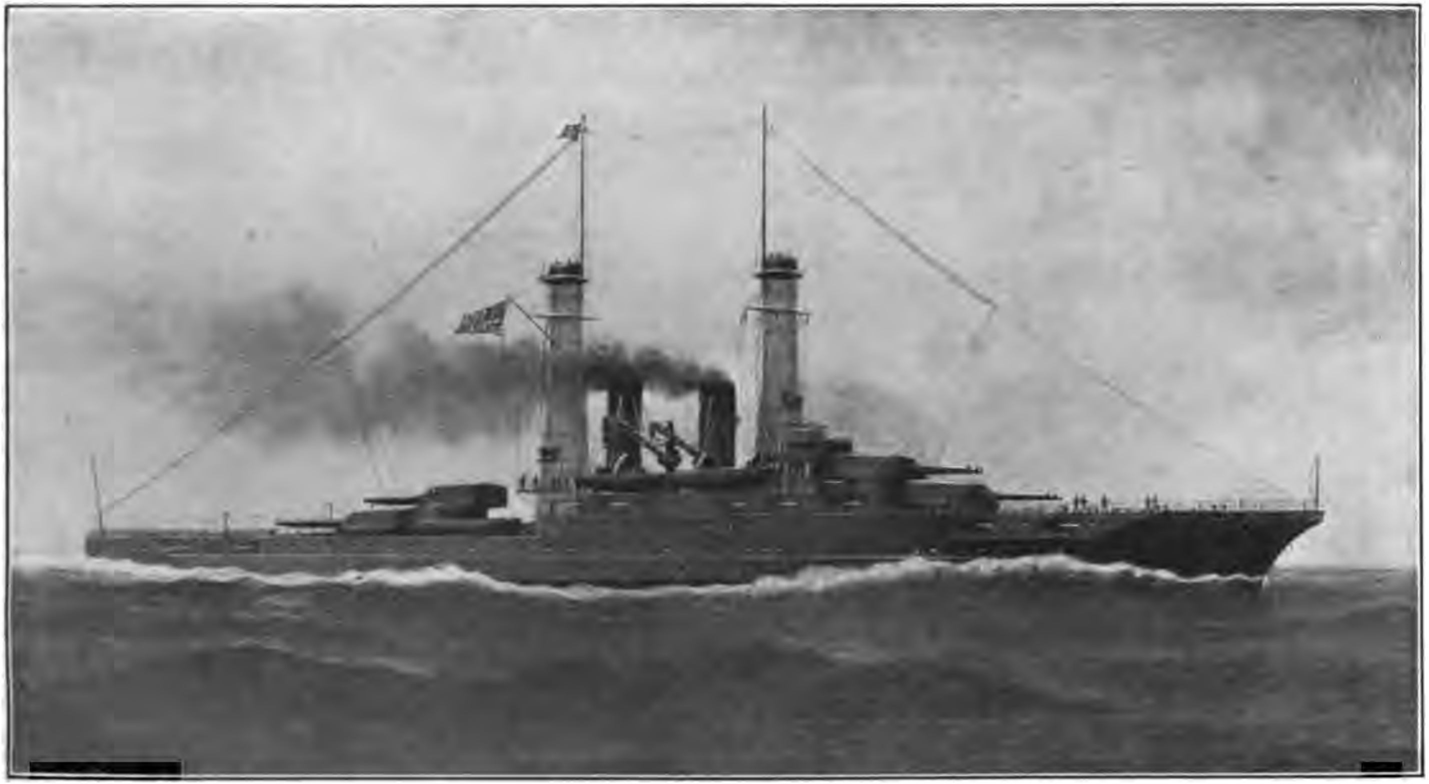
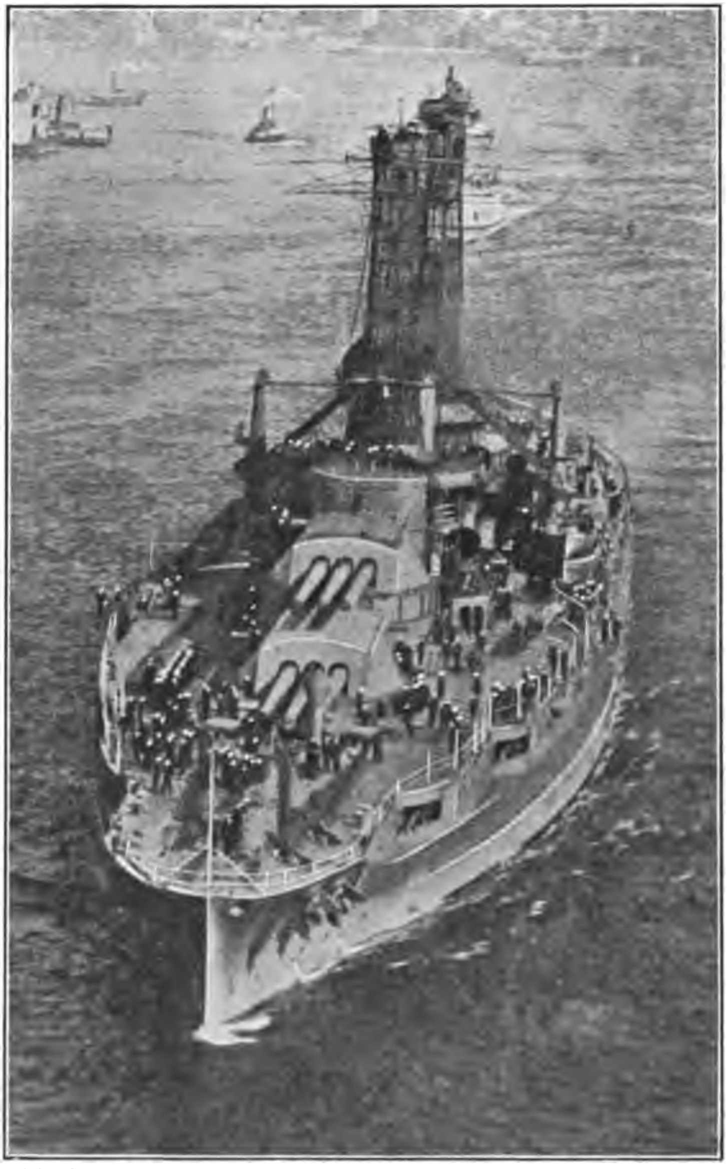


Scientific American. 1933

THE U. S. DREADNOUGHT "NEW MEXICO." ALSO "MISSISSIPPI" AND "IDAHO."
(THESE SHIPS ARE NOW UNDER CONSTRUCTION.)

DISPLACEMENT, 32,000 TONS. SPEED, 21 KNOTS. ARMOR: BELT, 14-INCH; TURRETS, 18-INCH. ARMAMENT: TWELVE 14-INCH, 50-CALIBER; TWENTY-TWO 5-INCH; TORPEDO TUBES, FOUR 21-INCH. COMPLEMENT, 1056 OFFICERS AND MEN main lattice mast. Forward on this deck are two turrets, each containing three 14-inch guns, those in the after turret firing above the roof of the foremost turret. On the main deck, aft are two three-gun turrets similarly disposed. This gives a concentration of six 14-inch guns ahead, six astern and a broadside fire of twelve 14-inch guns.



Scientific American. 1934

Battleship "Pennsylvania" Showing Forward 3-Gun Turrets

The three guns in each turret are mounted in a common sleeve, and are elevated, trained and fired as one gun. This arrangement greatly assists the spotter in locating the fall of the shots, and making the corrections necessary in the elevation. Moreover, the placing of three guns in one turret effects a valuable saving of weight.

An admirable feature of the *New Mexico* is the exceptional height at which the amidships battery of 5-inch torpedo-defense guns is carried. There are 22 of these guns, four mounted in casemates on the main deck forward, four in casemates on the gun deck aft, ten in a central battery, on the forecastle or spar deck, and four at the corners of the boat deck above the central battery. This arrangement gives a concentration of eight 5-inch guns forward and aft, and of eleven on each broadside.

A notable feature of this ship is the unusual extent and the great weight and thickness of the armor protection, which is more complete than that of any ship under construction for other navies, at least so far as is known. The great displacement of these ships—32,000 tons—has made it possible to clothe them with armor far in excess of that carried by the ships designed eight or ten years ago. Thus, the waterline belt, with a maximum thickness of about 14 inches, is 17½ feet wide, and this armor extends 8 feet below the waterline. The ship carries 16 inches of armor on the conning tower, and the port plates of the three-gun turrets are no less than 18 inches in thickness. Moreover, the whole side of the ship between the extreme turrets up to the main deck will be heavily armored, and with the side armor will be associated heavy transverse armor bulkheads and several horizontal armor decks.

The *New Mexico* is 600 feet long on the water line, 624 feet in length on deck; her breadth is 97 feet, her draft 30 feet, and her displacement 32,000 tons. She will be provided with four submerged 21-inch torpedo tubes, and her complement will consist of 1056 officers and men. Her contract speed is 21 knots.—*Scientific American.*

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RECORD GUNNERY BY THE *PENNSYLVANIA*

At the opening of the European war, battle practice with our 12-inch guns was carried on at ranges of about 10,000 yards; and it was believed generally throughout the fleet that we were firing at ranges equal to and generally greater than those used by foreign navies. The naval engagements of the war quickly dissipated that delusion—the cruisers of Craddock's squadron being destroyed at 12,000 yards; those of von Spee's squadron at 15,000 yards, and the engagements on the Dogger Bank and off Jutland opening at ranges of from 18,000 to 20,000 yards. Our battleships, consequently, are now doing their shooting with the main battery at ranges equal to these, and under the new conditions our 14-inch guns have been achieving some notable successes. The battleship *Pennsylvania* firing at a range of 20,000 yards, and using the new director system, made five hits on a moving regulation target out of a salvo of twelve 14-inch guns. In the following 12-gun salvo she made three hits. Eight hits out of 24 shots must surely be a world's record. Moreover, this was done with the new 14-inch gun, mounted in the new 3-gun turret.

Now in view of the fact that rumors have been running around to the effect that the 3-gun-per-turret mounting is a failure, this feat of the *Pennsylvania* is certainly very timely and should serve to set at rest any doubt as to the efficiency of the system. When it was first tried out experimentally, the three guns were fired absolutely simultaneously by the closing of a switch. It was found however, that the air waves set up by the projectiles had a tendency to throw them out of their true line of flight. The difficulty was overcome by firing the two outside guns simultaneously, and arranging the electric firing connections so that the middle projectile left the muzzle a small fraction of a second after the other two, causing it to follow them at at distance at which the "bow wave" and other air disturbances were not sufficient to affect the flight of the shell. This very simple device completely solved the problem, and the recent astonishing results obtained on the *Pennsylvania* prove that the difficulty of interference has been completely eliminated.

Another very gratifying feature in this performance is the fact that these results were obtained with the new 14-inch gun, which fires a 1400-pound shell with a muzzle velocity of 2600 feet per second and a muzzle energy of 65,680-foot tons. The theoretical penetration with this gun is 15.9 inches of Krupp armor at a distance of 10,000 yards. Evidently, the United States Navy possesses in this piece one of the most accurate and effective naval weapons in existence; and we may be sure that the results obtained by the *Pennsylvania* will give a keener edge to the controversy, which is raging over the question as to whether our future ships shall carry a battery of twelve 14-inch guns firing a 1400-pound shell or of eight 16-inch guns firing a 2100-pound shell. With gunnery of equal efficiency, the number of hits secured, were the *Pennsylvania* to substitute a battery of 16-inch for her present battery of 14-inch guns, the number of hits secured would be 5.3 instead of 8 out of 24 shots. On the other hand, the destructive power of the 16-inch shell, whose muzzle energy is about 100,000-foot tons, would be far greater than that of the 14-inch shell.

Another element regarding the *Pennsylvania's* record, which is giving great satisfaction to our Ordnance Bureau, is the fact that the firing was done under our new director system, which has been developed during the past few years after lengthy and careful experimentation. In this system, into the details of which it is not expedient to go just now, the whole of the battery is controlled and the pointing is done by a single officer chosen for his skill in holding the telescopic sights of the target. The system is so arranged that when the cross-hairs of his telescope are on the target, this officer knows that every gun throughout the battery is also on. It is evident that by this system those individual errors which must occur, when there is a gun-pointer for each gun, are eliminated.—*Scientific American.*

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THE 18-INCH NAVAL GUN

At the very time when a lively discussion is being carried on in our Navy Department as to whether the 14-inch or the 16-inch gun is the most efficient piece for the main batteries of our warships, word has come to official Washington, probably through our Naval Attaché, that the British have completed an 18-inch type gun, and that their latest dreadnoughts are to be armed with this enormous piece, the size and power of which will be understood when we remember that the largest piece now mounted in our Navy, the 14-inch, weighs sixty-three tons and fires a projectile of fourteen hundred pounds weight as compared with a probable weight of one hundred and fifty tons for the 18-inch gun and a weight of about three thousand pounds for its projectile. If the report be true, and we understand that it is credited by our Naval officers in Washington, it is in full accord with the recent trend of naval ordnance and it is guaranteed by the ever-increasing ranges at which naval actions have been fought during the war.

As we recently pointed out, the ships of the British Admiral Craddock were sunk at twelve thousand yards, and those of Admiral von Spee at fifteen thousand yards; while the North Sea engagements between the British and German fleets opened at ranges of from seventeen to twenty thousand yards. That accurate shooting can be done over these great distances is suggested by the recent performance of the *Pennsylvania* in putting eight out of twenty-four shots into the target at a range of twenty thousand yards.

Now, it was inevitable that the increase of the fighting range would be followed by an increase in the caliber of the gun, for the reason that as the range increases the punishing power of a big gun diminishes less rapidly than that of a smaller gun. Hence, if two fleets are able to do equally accurate shooting at, say, twenty thousand yards, it follows that the fleet which mounts the heaviest gun will do the greatest damage with each individual projectile that gets home on the enemy. It is well understood that only a certain amount of a ship's displacement can be allotted to her armament. If she carries a numerous lighter battery, she will land a proportionately larger number of shells on the enemy. If she mounts a smaller number of very heavy guns, like the English 18-inch piece, fewer hits will be obtained, but the damage done by each of the larger shells will be enormously greater.

It is not the number of shells that strike a ship, but the number of shells which get into the ship by penetrating her armor, that settle the question of her remaining afloat to fight, or going to the bottom. Moreover, of the shells that penetrate the armor, those of the largest caliber will do the most disruptive damage. Their fragmentation is larger, and each flying piece has therefore a proportionately greater tearing and penetrating effect. The fragments of a 12-inch shell which had come through the armor might fail to get through the protective deck into the vitals of a ship; whereas, the larger fragments of a three-thousand-pound shell might well be able to get through.

It is a suggestive fact that two of the British battle-cruisers destroyed by gun-fire in the Jutland battle received the fatal blow through the comparatively thin armor on the roof of their turrets, the exploding shell serving in some way to set off the magazines or a heavy local accumulation of shell and powder, and so tearing the ship asunder. Such penetration of horizontal or comparatively horizontal armor becomes increasingly possible as the fighting range increases and the angle of fall of the shell becomes steeper.

Furthermore, there is a steady increase of accuracy with the increase of size of gun and weight of projectile. More accurate shooting can be made with an 18-inch gun than with a 12- or 14-inch gun, particularly at the longer ranges. The modern system of spotting from an elevated position makes it possible to pull the salvos on to a ship at unbelievably great distances,—provided, of course, that the atmospheric conditions give good visibility. A skilled spotter, slung in a boatswain's chair from the masthead, would be able in clear weather to direct a salvo of 18-inch guns with deadly accuracy upon a battleship twenty-five thousand yards distant.

—*Scientific American.*

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THE BARLOW AERIAL TORPEDO[1]

The United States has now in its possession an aerial torpedo destined to mark a great advance in modern warfare. The chief point about the new engine of destruction is that it explodes at a given height above the ground, permitting the force to travel horizontally. All other attempts at firing shells at predetermined heights have been failures. The inventor of the new shell is Lester Barlow, a young man, who perfected his invention under the auspices of the United States Government, and who served as chief engineer under General Villa, when Villa and Carranza fought side by side to crush the government then existing in Mexico.

Barlow's torpedo was tested by the United States Government at Mineola, L. I., early in September. The report of the Army Ordnance Board signed by Lieut.-Colonel C. H. L. Ruggles, Ord. Dept., says, "The Barlow Aerial Torpedo is satisfactory. The action certain, the flight true, and the safety devices satisfactory."

The tests of September 6 and 7 were witnessed by Lieut. T. S. Wilkinson, U. S. N. Those of the 6th, 7th, and 8th by Capt. E. J. Ragsdale, Ord. Dept., and all by Lieut.-Colonel G. G. Gatley, Ord. Dept.

The torpedo was dropped from 2000, 3000, 4000, 5000, 6000, and 7000 feet. In two of the tests, light charges of high explosives were used—full charges would have endangered the community. The light explosive charges shook homes three and four miles away.

The new torpedo is seven and a half feet long. Its weight is one hundred pounds. It has a stream line to eliminate friction, thus ensuring the greatest possible speed between aircraft and target. Other shells of this character have been built to fall as slowly as possible to allow the mechanism time to work and explode the torpedo at a given point. The tests at Mineola showed that the Barlow torpedo will explode accurately to the inch of the point it is set to detonate. The aviator had nothing to do with the timing of the shell. It is automatically timed to explode at a given point, no matter from what altitude it is dropped.

The torpedo is carried attached horizontally beneath the aeroplane in traps, and is released by the moving of a small lever when the cross-wires in sighting apparatus designate the proper position. The torpedo sets itself after it has fallen three hundred feet. Before being released, it is absolutely non-explosive. In addition to the charge of high explosives, it is capable of carrying one thousand cubic feet of poisonous gases.

One battleplane, armed with such torpedoes, would pass the length of Manhattan Island and easily put the entire city out of commission. Each shell is capable of destroying one city block.

An important feature about the new engine of war is that outside of the casing of the torpedo, nearly every part is already under manufacture

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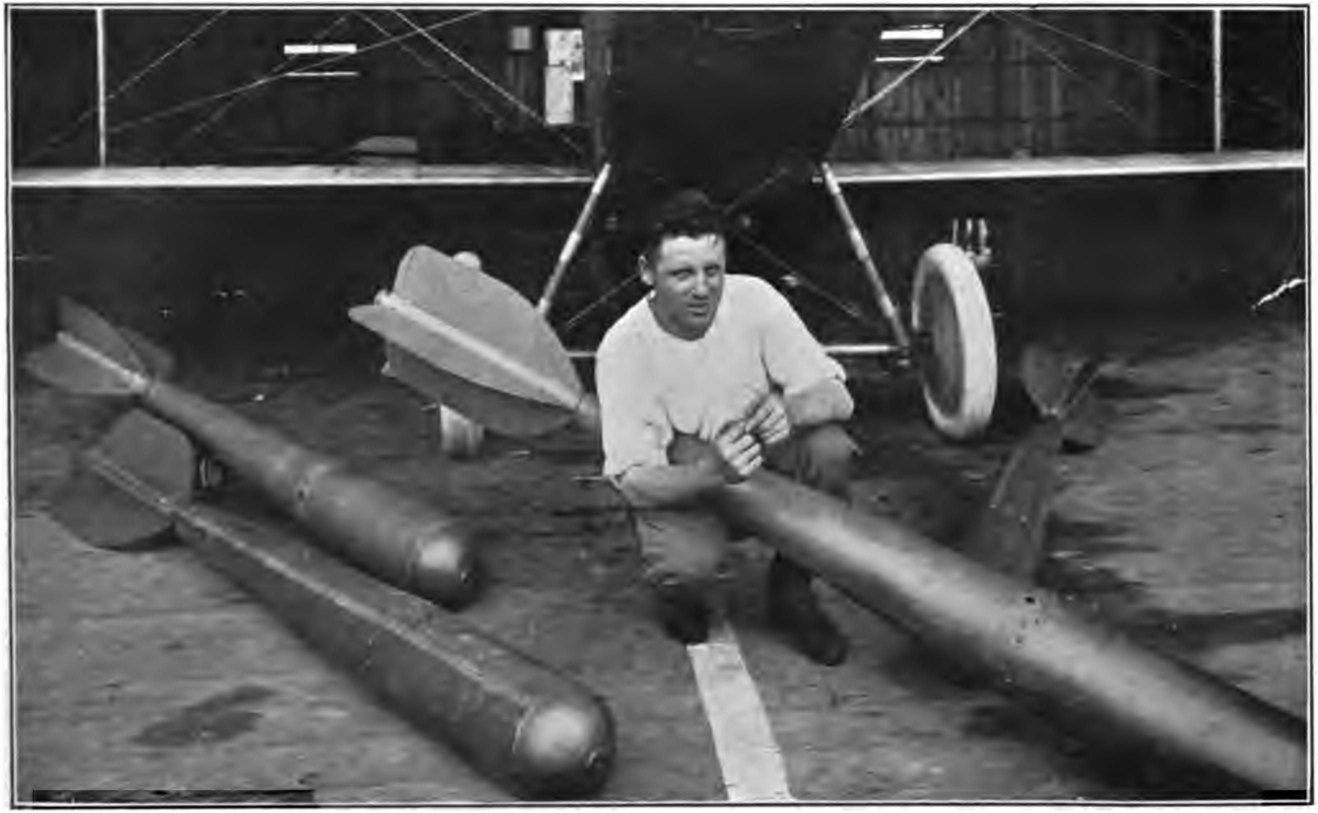
[1] From American Press Association.



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1886

BARLOW AERIAL TORPEDO

in the large wholesale hardware manufactories. Very little special machinery is necessary.

Owing to the necessity for secrecy, no one but the ordnance officers of the United States Army, Barlow's Attorneys and himself, know the exact construction of the torpedo, but it is known that there is nothing electrical in connection with it.

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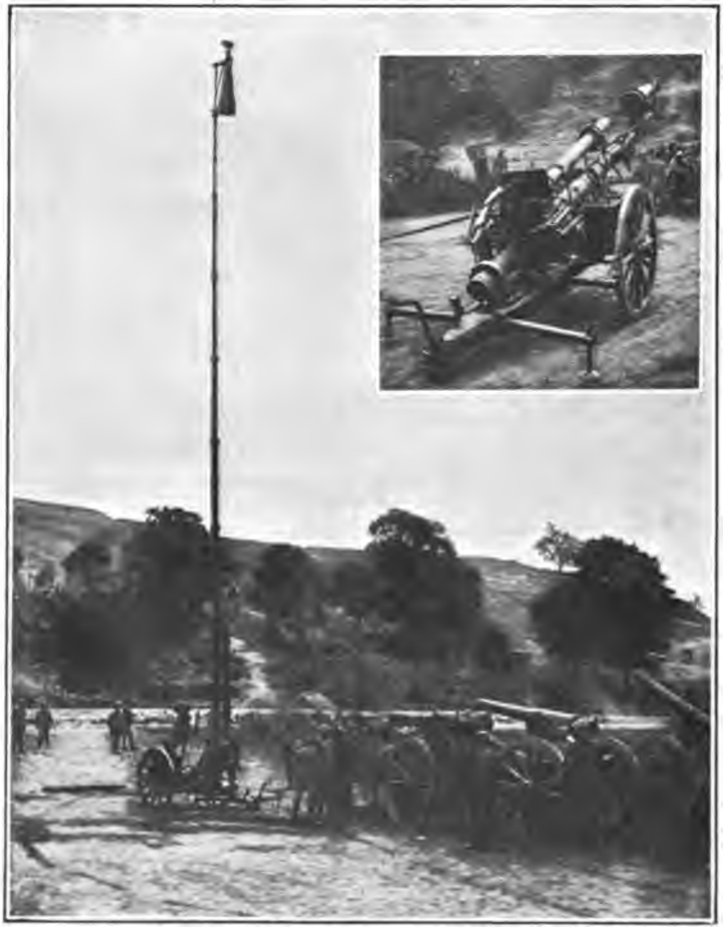
A GIANT GERMAN FIELD-PERISCOPE WITH TELESCOPIC TUBE, MOUNTED ON ITS TRAVELING CARRIAGE

This notable trophy was taken from the enemy by the French during the earlier battles on the Somme. It was captured in the wood of Assevillers, near the village so named, which is situated a short distance beyond Becquincourt and Fay, south of the river, and on the road to Péronne.



The London Electrotype Agency. 1936

In that district the French made their opening series of attacks in July. The main illustration shows the periscope on its wheeled travelling-carriage elevated to a height of 15 meters—approximately, 50 feet. It was constructed by Zeiss of Jena, and is fitted with exceptionally powerful lenses. For ordinary purposes, 15 meters is the height at which the apparatus is used, and its carriage supported the tube by itself at that elevation. To get the farthest possible view the periscope can be extended to 25 meters, being kept in position by means of stays and struts. The periscope, packed for travelling, is seen in the inset. It was like that when captured, and the French, it is said, at first thought it was a new piece of artillery.

—*The Illustrated London News.*

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MODERN ELECTRIC SEARCHLIGHT PROJECTORS

By J. H. Johnson, M. I. E. E.

(Extract)

Mirrors

The parabolic type of mirror, in which all the light rays from the focus are projected after reflection in a direction parallel to the axis of the mirror, is almost universally adopted. The focal length or the distance between the center of the positive carbon crater and the center of the mirror face depends on the degree of efficiency desired, the design of the mirror, and the projector barrel. It has been previously mentioned that the efficiency is highest with mirrors of large focal length up to 50 to 60 per cent of the mirror diameter, but in the larger sizes of projectors from 36-in. and upwards the longer length of barrel may necessitate a special construction of the turntable and supporting arms to permit of operating at 90 deg. elevation. The center of the mirror practically reflects no light; the shadow of the negative carbon on the mirror is therefore negligible. It is for this reason that in certain makes of small projectors having a short focal length the negative carbon protrudes through a hole at the center of the glass or metal mirror.

The usual form of mirror adopted in England, Italy, and America is of plate glass pressed to shape and afterwards accurately ground. The back of the mirror is silvered—chemically deposited—and protected with a layer of copper deposited electrically. All mirrors should be carefully tested for spherical aberration in order to ascertain that different sections of the mirror have the same focus, otherwise a serious loss in efficiency will occur. The most frequent troubles are due to the outer edge not being in focus with the center, but this is principally in connection with metal mirrors, which are easily distorted.

The usual method of testing the accuracy of mirrors is to arrange a framework to carry two sets of parallel wires at right angles to one another, and the image formed by the mirror of this frame should be free from distortion. Commercial mirrors of the glass type can be obtained with a guarantee that the focal length of a 36-in. mirror will not differ from the correct value by more than ⅜ in. and in a 24-in. projector by ¼ in. Mirrors are also tested for temperature and deterioration for many hours in a projector burning the normal current, and the temperature at the top of the [illegible] mounted [illegible] They are also m- [illegible] and for tracks [illegible]

[illegible] of the mirror and the target is usually carried out [illegible] but in the projectors of about

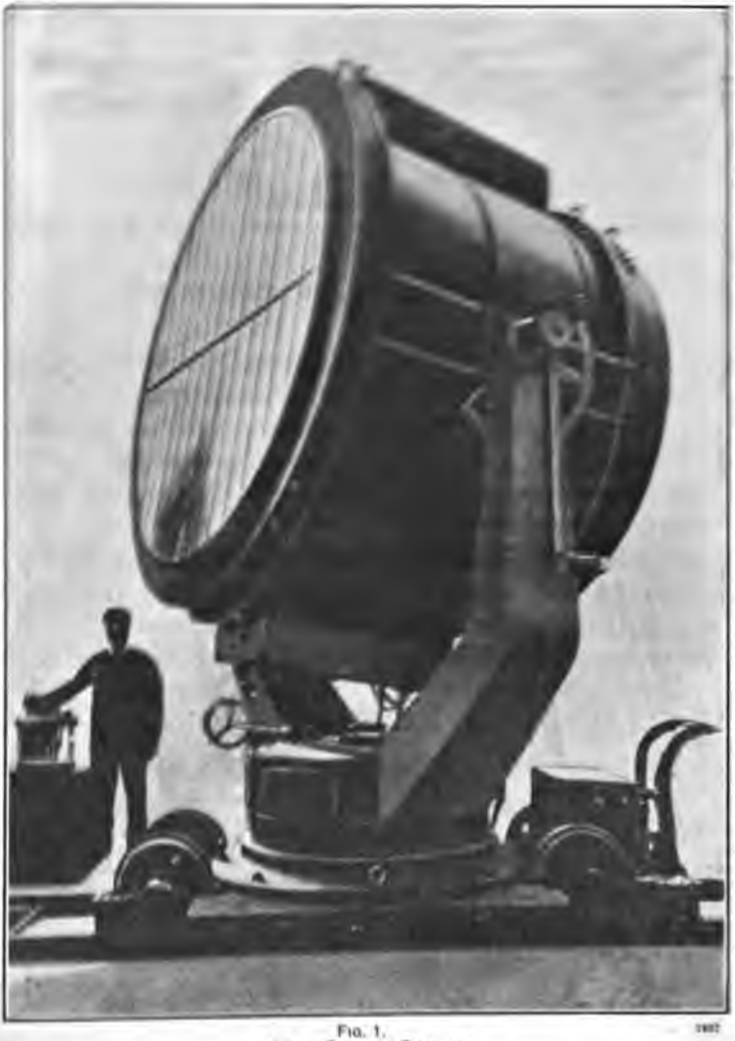

Fig. 1.
84-Inch Fortress Projector

1907

to 42-in. diameter, burning with a high voltage arc and a short focus, ial ventilation is sometimes advisable; this takes the form of a small ugal fan placed at the center or base of the mirror and discharging a of air across the face of the mirror. In the "Galileo" projector, s of which are illustrated in Figs. [1, 2, and 3], one of these centrif- is fitted to the center of the mirror back.

The mirrors are protected against excessive vibration by supporting them with a number of flat springs fixed at the circumference of the metal mirror back, but as an extra protection for mirrors of the military type, which are subjected to the shocks of gun-fire and explosion, the back of the mirror is directly protected either by wire netting or a thin sheet-lead backing. Under these conditions the mirrors are still able to operate successfully, although perforated by rifle shot.

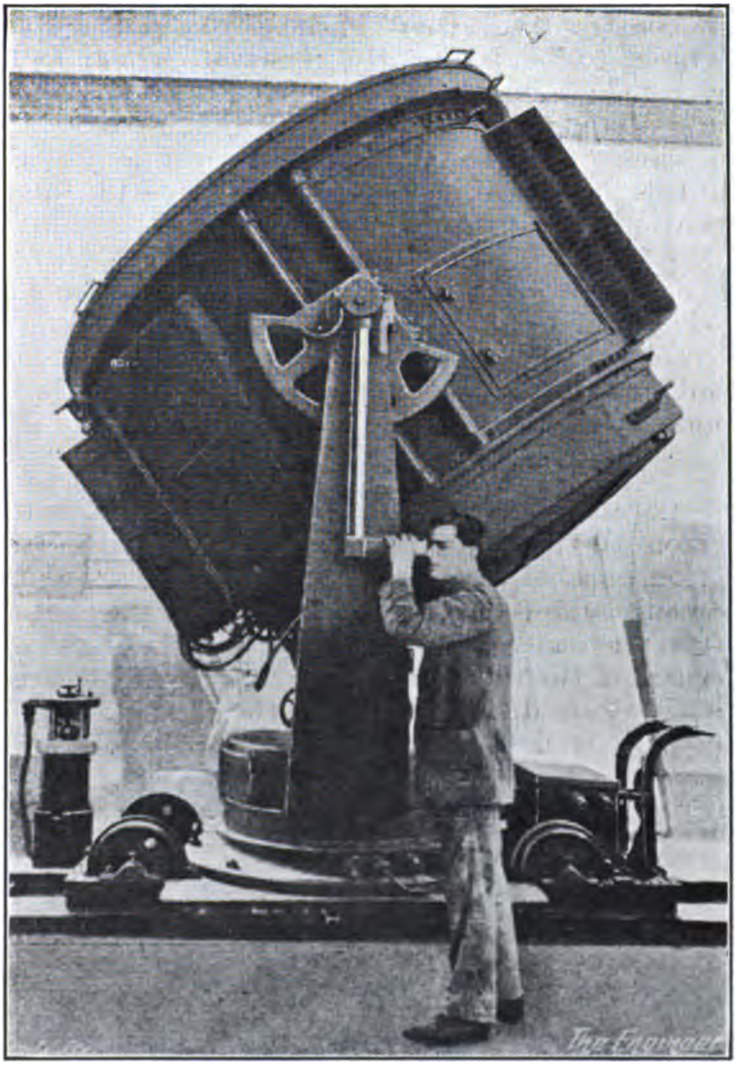

FIG. 2.
VIEWING ARC IN PROJECTOR

1936

In the smaller sizes of projectors it is not always necessary to protect the mirror face against pieces of glowing carbon when operating with a

90 deg. elevation, but it is advisable with these mirrors to protect the surface in the larger sizes above 36-in. diameter when working with a high voltage arc and small negative carbons, owing to the thick copper coating—which increases the conductivity of the negative carbon—falling on the

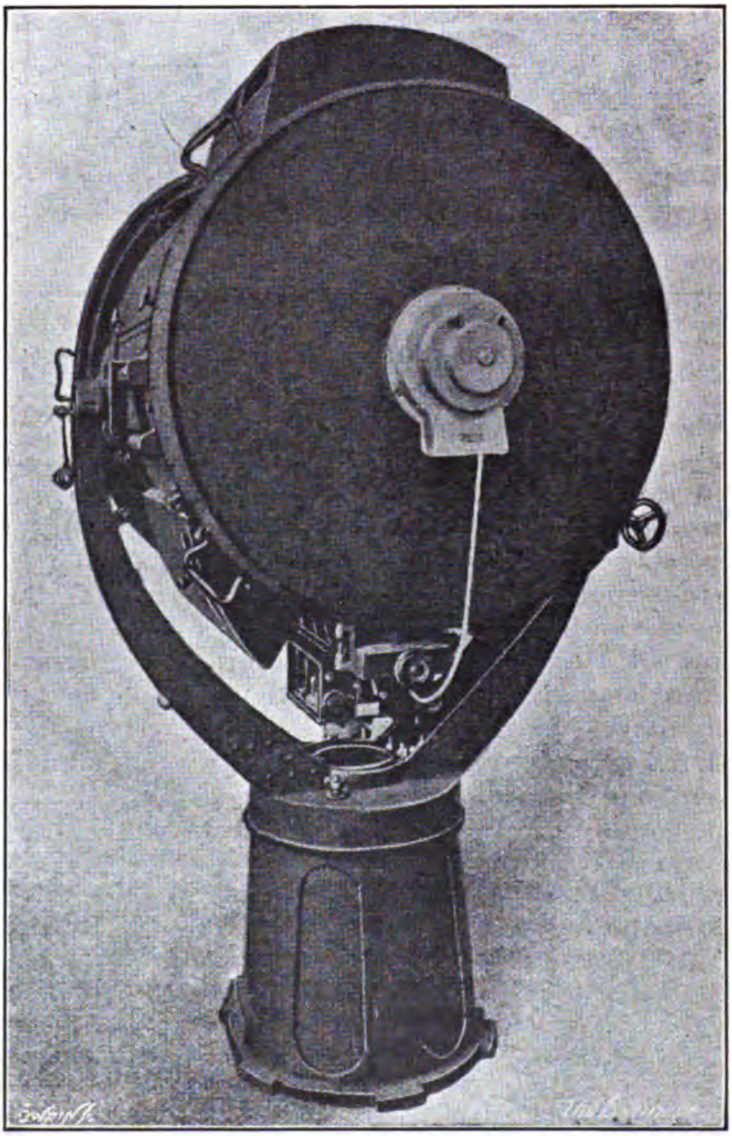

FIG. 3.
PROJECTOR WITH FAN-COOLED MIRROR

1939

ror as molten copper, which would eventually injure the mirror face. protection can either take the form of a coned cage of wire gauze or a ow disc of suitable material, such as mica, which is loosely supported from the negative carbon so that it swings freely and catches the pieces of hot carbon or copper when the projector barrel is operating at any elevated position up to the maximum.

Metal and gilded mirrors are usually employed in France, and although they are more mechanical than glass mirrors they do not possess a higher efficiency, but are more liable to distortion, due to the widely varying temperatures of the mirror. They possess, however, a slight advantage in respect to the penetrating effect of the light beam from the gilded mirror in a foggy or misty atmosphere.

Mirrors originally designed by Col. Mangin are principally used in France, and although they are extremely accurate, they have the serious disadvantages of high price, difficulty of manufacture, and heavy weight. They are not often used in projectors of modern construction unless it is essential to obtain a mirror with a high degree of accuracy and having a small angle of divergence. The mirror is of glass with thick edges, graduating down to the minimum thickness at the center, there being two concentric spherical surfaces of different radii which allow for the refraction to be corrected for spherical aberration.—*The Engineer.*

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DIESEL ENGINES v. STEAM TURBINES

A comparison of the cost of generating power by means of Diesel engines and steam turbines, together with a discussion of the different factors governing the profitable use of either type, is given in a paper to be read this month by Mr. Herbert Haas at the Arizona meeting of the American Institute of Mining Engineers. The author says that in places where neither cheap coal nor water power is available, and the price of oil fuel is increased by cost of carriage, the Diesel engine will become a prime mover of increasing importance. Where water is scarce the Diesel engine also shows to advantage, because about twelve times as much water will be required for condensing purposes with steam turbines under general conditions as is needed for jacket cooling of the two-stroke engine, while engines of the four-stroke pattern require only one-twentieth of the water. The table of costs [p. 392] of generating power with four 2000-kw. Sulzer-Diesel engines, direct-connected with alternators and exciters, is based on a fuel cost of 5s. per barrel of 320 lb., and lubricating oil cost of 1s. 5d. per gallon:

The kilowatt-year is equivalent to 8760 kilowatt-hours. Three units work continuously, and one acts as a stand-by and the cooling water in circulation for 9000 horse-power, working continuously, amounts to 8000 to 11,000 cubic feet per hour with re-cooling arrangements.

In Table II the costs of operation under similar conditions, with power generated by two 6000-kilowatt turbines, are shown. The turbines work with steam at 180 lb. pressure per square inch, steam temperature 620 deg. Fah., inlet temperature of condensing water 60 deg. Fah., discharge temperature 75 deg. Fah., quantity of cooling water per 6000 kilowatt unit, 74,000 cubic feet per hour. One generating set works continuously at full load and the other is a stand-by:

The selection of two 6000-kilowatt rather than three 3000-kilowatt steam turbines is made on account of the greater efficiency of the 6000-

kilowatt sets, while the selection of four 2000-kilowatt Diesel engine units is justified by the author on the ground that larger engines are not any more efficient in fuel economy, and the relative much higher cost of this prime mover makes it a good policy to reduce reserve capacity to a safe minimum.

The author concludes that in general the selection of either type of prime mover will be governed by the following economic considerations: (1) Fuel is of chief influence on the total power cost, where both the B.T.U. price and load factor are high. These conditions favor the use of the Diesel engine. (2) Interest and redemption (amortization) are of chief influence on the total power cost with low B.T.U. price and low load factor. This applies particularly to stand-by plants, which are operated only occasionally or have to supply recurring peak loads. The installation cost of such plants must be kept as low as possible so as to avoid heavy capital charges distributable over a relatively small kilowatt-hours output of the station. Such conditions favor the steam turbine. (3) Exceptions to (2) are cases where the constant and instant readiness of the Diesel engine give it preference, and installation cost is of secondary importance. Here it is necessary to balance the cost of keeping boilers under steam continuously against the difference of interest charges of steam-turbine and Diesel engine plants. (4) For power plants erected at the source of the fuel, either in the oil fields,

TABLE I

Cost of Generating Power with Four 2000-kilowatt Sulzer-Diesel Engines Direct Connected to Generators and Exciters

	Full load.	¾ load.	½ load.	¼ load.
	12,000 h.p. 8,000 kw.	9,000 h.p. 6,000 kw.	6,000 h.p. 4,000 kw.	3,000 h.p. 2,000 kw.
Kw.-hr. per year	70,000,000	52,500,000	35,000,000	17,500,000
Barrels	140,000	105,000	70,000	35,000
	Cost per year. £	Cost per year. £	Cost per year. £	Cost per year. £
Fuel cost	35,000	26,200	17,500	8,750
Labor	3,780	3,780	3,780	3,780
Lubrication	6,130	4,599	3,066	1,533
Maintenance	1,440	1,440	1,440	1,440
	£	£	£	£
Total direct	46,350	36,019	25,786	15,503
Interest and amortization	17,280	17,280	17,280	17,280
	£	£	£	£
Total cost	63,630	53,299	43,066	33,783
Cost per kw.-year	7.9	6.6	5.4	4.2

or at the coal mine, prime movers will be selected costing least to install, *i.e.*, steam turbines, since fuel expenditures will weigh less than interest and redemption charges. (5) In many cases combination plants using Diesel engines for supplying the continuous and nearly constant main load, and steam turbines for furnishing periodically occurring peaks by the use of high-duty boilers with large water and steam spaces, capable of being forced when necessary, will prove most profitable. (6) Steam power will remain the cheapest power wherever waste-heat gases are available, as, for instance, gases from reverberatory smelting furnaces, where nearly one-half of the fuel used in smelting can be utilized for steam generation. Nearly 3,000,000 B.T.U. for every ton of charge smelted are thus available for steam generation, or about 150 horse-power-hour per ton of charge. (7) Up to capacities of 1000 horse-power steam turbines can compete with Diesel engines only in special cases, such as supplying exhaust steam for heating purposes. For such small units, particularly for greatly varying loads, reciprocating steam engines are preferable. For larger plants, from 1000 to 10,000-kilowatt capacity, careful analysis must be made of the relative advantages of Diesel engines and turbines, a knowledge of the load factor, fuel prices, and water conditions being necessary. For power plants larger than 10,000 kilowatts, using units from 6000 kilowatts upwards, steam turbines have the preference, unless a combination of high load factor, high fuel cost, and poor water conditions favor a Diesel plant.—*The Engineer.*

TABLE II

Cost of Generating Power with Two 6000-kilowatt Steam Turbines

	Full load.	¾ load.	½ load.	¼ load.
	8,000 kw.	6,000 kw.	4,000 kw.	2,000 kw.
Kw.-hr. per year	70,000,000	52,500,000	35,000,000	17,500,000
Barrels	300,000	210,000	150,000	83,700
	Cost per year. Per kw.-hr.	Cost per year. Per kw.-hr.	Cost per year. Per kw.-hr.	Cost per year. Per kw.-hr.
	£	£	£	£
Fuel cost	75,000	52,400	37,400	20,925
Labor, etc.	5,000	5,000	5,000	5,000
Maintenance	1,440	1,440	1,440	1,440
	£	£	£	£
Total direct	81,440	58,840	43,840	27,365
Interest and amortization	17,280	17,280	17,280	17,280
	£	£	£	£
Total cost	98,720	76,120	61,120	44,645
Cost per kw.-year	12.2	12.6	15.2	22.3

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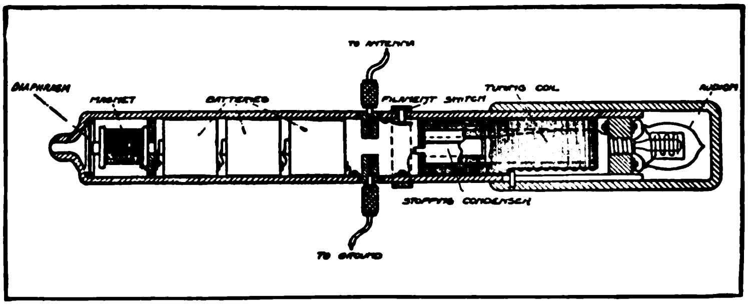
THE "FOUNTAIN PEN" RECEIVER—A PORTABLE WIRELESS RECEIVING SET

So numerous have pocket wireless sets been in the past that they have long since ceased to be a novelty. Yet the so-called "fountain pen" receiver recently developed by Dr. Lee DeForest directs attention to itself on the part of electrical and wireless men, because of the unusual degree of newness presented in its design.

The "fountain pen" receiver is a complete wireless receiving set no larger than some of the extra-sized fountain pens in use by men with heavy hands. With it wireless signals from stations up to 8 or 10 miles can be intercepted without difficulty, in conjunction with even a small aerial. This means that a man with one of these receiving sets, stationed in Manhattan, would have no difficulty in reading all the wireless messages which might be sent out from the United States Navy Yard in Brooklyn.



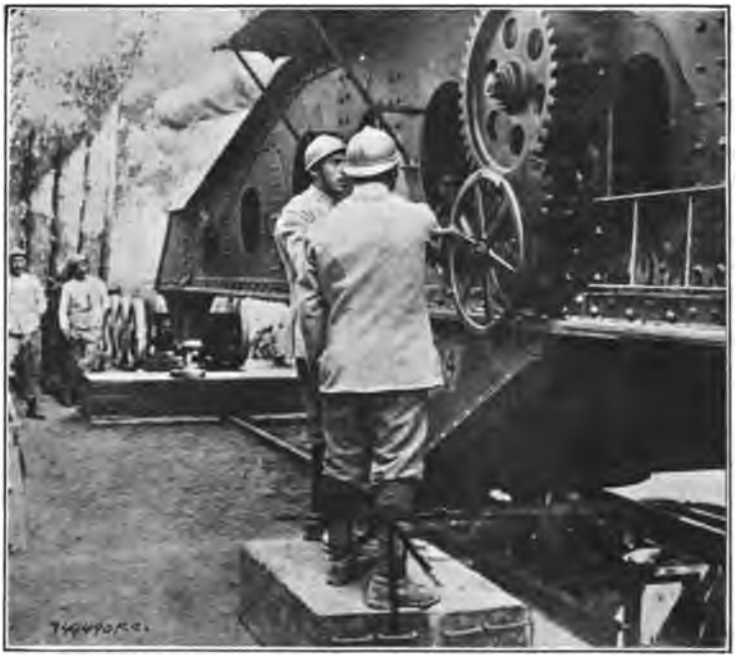
SECTIONAL VIEW OF "FOUNTAIN PEN" RECEIVER FOR WIRELESS SIGNALS 1940

The new instrument, a sectional view of which appears in the accompanying illustration, depends entirely upon the audion bulb for its efficiency. It is this sensitive form of detector that makes the "fountain pen" receiver feasible. It is possible, by using a very "soft" audion, to get fair sensitiveness with only four volts for the B battery, whereas in the ordinary receiving set employing the audion the B battery usually has a potential of many times that. Although by making the case longer, it is possible to use a higher voltage B battery, the inventor states that this is not necessary.

It will be noted that the tuning of the new set is accomplished by means of a tuning coil wound with No. 40 wire. Taps taken from the coil are led to a number of points over which slides a contact mounted on the movable cap at the end of the receiver. By moving the cap one way or the other the wavelength of the receiving set is altered to meet the wavelength of incoming signals. The tuning coil can be operated satisfactorily for short wavelengths, and the audion is connected directly to it, giving an untuned secondary. The battery is placed in the middle of the receiver, while at the very end is placed the telephone consisting of the magnet, bobbins, diaphragm, and a special ear piece. The antenna and ground connections are made by means of bayonet contacts fitting into contact holes.

To use the instrument the operator should have a metal plate on the heel of one shoe, to which is attached the ground wire leading to the set. The wire can be passed through his trousers so as to be inconspicuous. The wire to the antenna may be run down through the coat sleeve into a hollow cane and through to the ferrule. Standing against any iron fixture running into the ground, the operator should place the metal plate on the heel of his shoe against the iron, meanwhile holding his cane over his shoulder. The ear piece is then placed in one ear, while the cap at the free end is moved back and forth to tune the set to the desired signals.—*Scientific American.*

* * *



Photograph from Underwood and Underwood. 1041

Traveling and Firing Carriage for the French 13.5-inch Gun showing Part of the Elevating Mechanism and the Means for Transferring the Shock of Discharge from the Wheels to a Concrete Base.

BOOK REVIEWS

Aircraft in Warfare. By F. W. Lanchester, M. Inst. C. E., M. Inst. A. E., Member Advisory Committee for Aeronautics, Author of "Aerial Flight," "Aerodynamics," "Aerodonetics." New York: D. Appleton & Company. 6½" x 10". 222 pp. 20 figs.; 14 plates. Cloth. 1916. Price, $4.00.

This book consists of a series of articles published in *Engineering* from September to December, 1914.

The first chapter discusses the advisability of considering the air service as a fourth arm of the military organization, and when that chapter was written (Sept. 4, 1914) the author regarded such a designation as of a tentative and experimental character, although he was of the opinion that "air service was destined to become as important an auxiliary to an army in the field as the cavalry."

The author then calls attention to what he believes are the primary and secondary functions of the aeronautical arm.

The first he defines "as comprised by its duties and actions relating to the three pre-existing arms of the service—viz., the infantry, cavalry, and artillery;" the second being defined "as comprised by its duties in the attack on, and defense from its like arm—i.e., the destruction or countering of hostile aircraft."

Then follows a discussion of the aeroplane versus the airship or dirigible in which is contrasted their respective merits and limitations.

Several chapters are then devoted to the strategic and tactical uses of the aeronautical arm; but the chapters that will probably be the most talked of are those in which the author deduces and discusses the *n-square* law which is expressed as follows:

"Under the conditions of modern warfare the fighting strength of a force, so far as it depends upon its numerical strength, is best represented or measured by the square of the number of units.

"In all cases where the individual fighting strength of the component units may be different it has been shown that if a numerical fighting value can be assigned to these units, the fighting strength of the whole force is as the square of the number multiplied by their individual strength.

"Where the component units differ among themselves, as in the case of a fleet that is not homogeneous, the measure of the total of fighting strength of a force will be *the square of the sum of the square roots of the strengths of its individual units.*"

This law is represented graphically, and its application shown by historical examples the principal one being Nelson's tactics at Trafalgar where, is is suggested, "that Nelson, if not actually acquainted with the *uare* law, must have had some equivalent basis on which to figure his al values."

This chapter should be carefully read by all soldiers.

The author then discusses the subjects of the attack by aeroplane on aeroplane, the fighting machine and its armament, rapidity of fire and its measure, armor in its relation to armament, gun-fire ballistics, aircraft in the service of the Navy, international questions relating to aircraft in war, future of the fourth arm, and then adds a chapter in the form of an appendix on the Lewis gun as an aeroplane arm.

It should be noted that the last chapters were originally published in December, 1914.

Since that time, however, great progress has been made in air service and yet practically nothing of importance has been accomplished that was not predicted and scientifically discussed by the brilliant author of this book.

In the preface, written by Major-General Sir David Henderson, K.C.B., Director General of Military Aeronautics, it is stated that of the students of military aeronautics who by reason of their receptive minds, and their wide and varied experience, have mastered so many of the fundamental problems, that they are well qualified to review the general position, none has a wider view than Mr. Lanchester.

◆ ◆ ◆

The Submarine Torpedo Boat. (*Its Characteristics and Modern Development.*)
By Allen Hoar, Junior Member American Society of Civil Engineers.
New York City: D. Van Nostrand Company, 25 Park Place.
5¼" x 8". 211 pp. 84 il.; 4 folding plates. Cloth. 1916. Price, $2.00.

As stated in the preface, the author has "in a non-technical language in so far as possible brought to the attention of the reader the inherent characteristics of the submarine boat, the problems involved in its design and construction, the difficulties of operation, its present limitations, and its future possibilities."

In tracing the development of the submarine, the text starts with the "first known device of this kind," the boat conceived by a Hollander, Dr. Conelius van Drebbel and constructed by him in 1624.

Then comes David Bushnell's *Turtle* in 1772, Robert Fulton's *Nantilus* in 1802, the various types used during our Civil War, and finally the present-day boat.

When it is noted that as late as 1902 many of our naval officers did not consider the submarine to be sufficiently developed for any practical use in warfare, the advance in this naval auxiliary has indeed been rapid.

This advance is attributed by the author "to the systematic study given to the submarine both from a military and an engineering standpoint by naval experts and authorities who have had experience in handling the subject, and by the requirements laid down by naval officers who have gained experience in this particular field under actual service conditions."

Among the characteristics the author lays stress upon are sea-worthiness, controllability, reliability of engines and power-plant, speed, quick submergence, and habitability.

Types and designs are treated scientifically but in a manner that the man of average technical education can easily understand.

Power-plants are described and the advantages and disadvantages of the Diesel engine are pointed out.

While the author does not decry the Diesel engine as a type, he prefers the present reliability of the gasoline engine to the economy of the Diesel.

The steam engine as a probable prime mover is discussed, and storage batteries and motors are described.

The author also points out that "the ideal form of power plant for the submarine, as may be easily understood is one that is capable of operation both when on the surface and when in the submerged condition, that is, in other words, a single unit which will do away with the present dual system."

A chapter is devoted to the future development of this craft and reference made to the fact that "there remains a great many disconcerting problems to be solved before anything like perfection is reached."

Means of defense against submarine attack and the tactical evolutions of this type of vessel are discussed with clearness.

Then follows a history and description of the torpedo, of tenders and salvage ships, and then there is a final chapter on submarine mines.

Upon reading the book and examining the numerous plates, one feels that he has covered everything pertaining to the subject.

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Radiodynamics: The Wireless Control of Torpedoes and Other Mechanism.
By B. F. Miessner, Expert Radio Aide, U. S. Navy. New York City: D. Van Nostrand Company. 5¾″ x 8″. 206 pp. 112 il. Cloth. 1916. Price, $2.00.

In this interesting volume, the author presents in an orderly as well as instructive manner the essentials in the history, methods, and apparatus of radiodynamics. A cursory treatment of the telephone and telegraph systems is found, together with the various wave systems, such as the electromagnetic, sound, infra-red or heat, visible and ultra-violet waves, as well as earth conduction.

About fifty pages are devoted to describing the advent of wireless controlled torpedoes, the European control systems, and also the developments at the Hammond Radio Research Laboratory up to and including 1912. This, while of interest to the lay reader, is simply a matter of history to the radio engineer.

About thirty pages are devoted to the solution of battle-range torpedo control, difficulties encountered in providing interference preventers and methods of obtaining selectivity. These subjects are well illustrated by diagrams and charts showing results of tests.

Very interesting is the author's treatment of indicator currents in radio receivers. The results he obtained from tests are, however, at variance with the treatment of this subject by Dr. Pierce. This chapter will, no doubt, prove of greater interest to the radio engineer than to the lay reader.

An interference preventer devised by the author for use with the different systems, such as the spark and continuous wave generator, is also discussed. He utilizes the fundamental principles relating to the flow of direct and alternating currents for the production of a highly selective radio system. These properties may be so varied as to make the circuit conductive to currents of varying currents, while greatly resisting the flow of constant value, and vice versa. As stated by the author, the different systems produce considerable mutual interference; hence by the use of suitable apparatus he differentiates between the two kinds of effects at the receiving station and thus secures selectivity to a greater degree. These methods are well illustrated by schematic representations of receivers showing reduction interference between spark and undamped wave systems.

About twenty pages are devoted to detectors, amplifiers, relays, and torpedo antennæ. The chapter on detectors is rather brief; but those interested in vacuum detectors are referred to excellent sources for more detailed description. The subject matter of torpedo antennæ bear chiefly on the work of Hammond's laboratory by the author, though the water and the submerged receiving type of antennæ are touched upon. These latter types have apparently been abandoned by the Navy after tests of a somewhat extended order.

The chapter on recent developments refers primarily to the Hammond torpedo, though it includes work done only up to and including 1912. It is rather disappointing, in a way, that the results of this work could not have been brought up to the present time by the author, as the treatment of that part touching on Hammond's boat belongs in the category of past work and is historical, rather than presenting the facts as they exist today. The chapter is concluded by a description of the "electric dog," devised by the author and Mr. Hammond, wherein is embodied the principle of automatic direction by means of a suitable orientation mechanism of which the two selenium cells correspond to the two light sensitive organs of the moth. As is known, the moth possesses two minute cells sensitive to light. When either of these is illuminated to the exclusion of the other, it experiences sensations similar to pain, thus causing it to move about until in a position where the light strikes both lenses equally where the unpleasant sensation ceases. This causes the moth to fly directly towards the source of light. The orientation mechanism installed in the torpedo causes it to move towards the source of light, as for example, the enemy's searchlight. This chapter is also well illustrated.

The book contains more information on this subject than can probably be found elsewhere by the general reader, and will give him, as well as the trained engineer, a brief history and exposition of the methods and some of the apparatus used in radiodynamics to within comparatively few years. Moreover, it is a book that can be read with profit by the general reader, and he will be impressed as well as enlightened by the comprehensive yet brief treatment of the general subject when following the successive steps in the development of this force. The reader will find a great part of the volume devoted to torpedo control applications of radiodynamics, but that is due to the fact that most of the developments in the "art" have been of a military nature. The subject matter is well planned and the diagrams clear and well rendered.

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Infantry Drill Regulations United States Army 1911. (Changes to August 25, 1916.) Simplified, with Annotations, Illustrations, and Index, by Major Jas. A. Moss, U. S. Army. Menasha, Wisconsin: Geo. Banta Publishing Co. Sales Agent: Journal U. S. Artillery, Fort Monroe, Va. 4½" x 5¾". 331 pp. Cloth. 1916. Price, $0.75 postpaid.

As stated in an explanatory note, this illustrated and annotated edition of the *Infantry Drill Regulations* is an exact reproduction of the authorized War Department edition, with the addition of the following, which in no way affects the original text: The index, the illustrations, the author's notes, the paragraph headings and the paragraph numbers (in parentheses) inserted in various places.

The more one is obliged to use the drill book, the more he will be impressed with the method adopted by Major Moss.

The index in itself will be found of the greatest benefit; and the figures and notes, placed by the author throughout the book, explain very clearly and concisely many subjects which would otherwise require special effort.

The paragraph headings add so much to the ease of finding quickly what is wanted that one wonders why the idea has not been adopted before.

The book should be in every company office of both the Regular Army and the National Guard.

* * *

Americanism—What It Is. By David Jayne Hill, LL.D. New York City: D. Appleton and Company. 5½" x 7½". 280 pp. Price, $1.25.

An excellent and timely discussion of one of the burning questions of the day.

While not a military work, Dr. Hill has given his countrymen a valuable addition to their educational resources. Civilian and military, especially younger citizens, should read carefully what he has written for the broadening effect on their minds.

The chapter on the "American Conception of the State," places our country in strong contrast with the most liberally governed of the Old World countries.

The crisis in constitutionalism is a rather new and advanced view of the general subject of amending the Constitution. Some of our intelligent and patriotic fellow countrymen are wont to speak irreverently of "Our 18th Century Constitution." These are now invited to look on that document from a human standpoint.

We think the author loses sight of the balance wheel of common sense possessed by the American people as a nation.

His fears of attack on the Constitution are undoubtedly genuine; but, in the light of past crises through which the common sense of our fellow countrymen has carried them, we cannot believe there is the grave danger that Dr. Hill sees.

Education is the great safe-guard we should strive to raise up for our Constitution and the political principles under which we have, as a nation, become a power for good in the world.

Undoubtedly true Americans who believe in the permanence of our country should do all in their power to resist radical changes that may attack the fundamental law on which our democracy is founded.

The reading of this book by the thoughtful conservative element of the country is greatly to be desired. Such works lubricate the bearings of the "balance wheel" and make it run true.

The chapters on "Taking Soundings" and "The Tests of American Democracy" are full of food for thought and educational value, besides being written in interesting literary style.

The conflict between Imperialism and Democracy is lucidly treated and should be carefully read and understood by those young Americans who shall presently have on their shoulders the load of responsibility that must guide and safe-guard our heritage of liberty.

When the author attempts to show how far our government should follow up and protect those of its citizens, who, as adventurers and promoters in foreign lands, obtain concessions to exploit natives, he opens up a subject difficult of discussion because the merits of each case must be known. The promoter is always the loudest shouter of that much misused phrase "vigorous foreign policy." The innocent and legitimately intentioned American under these circumstances must always suffer by such association.

Under the caption "The Duty of National Defense" the author pays his compliments to the pacifists in forcible and, for the most part, logical reasoning, and it would be desirable for all the universities and other schools of higher education to have their senior classes instructed in this matter by lecture or reading prior to their going forth to become full-fledged citizens. His "million young Americans" would profit by taking this lesson into their lives as members of the body politic.

Officers of the Services should also read this chapter, not because they need instruction in National Defense, but because of its educational value.

It is regrettable that faulty logical reasoning should be found in such a work, but should we deduce general propositions from particular cases? Even if one, or one dozen of the most highly trained diplomats in Europe inform us that the United States has lost its "former international prestige" is not the "wish father to the thought"? After all, these are individual opinions and some of us have the temerity to believe that experts are not always right in their opinions.

No man is wise enough to predict what is going to happen, or to tell us what would have happened even if he is the best trained diplomat in Europe.

The book is one of the strongest arguments for preparedness and national defense that has yet appeared from a civilian's pen, and should be read by all our peace-at-any-price friends.

It is a scathing arraignment of those demagogues and agitators, who, working on the emotions rather than appealing to the reason of our fellow citizens, would go to any length to embroil us in foreign or domestic trouble for their own selfish ends.

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First Days in Manila. 5½" x 8½". 51 pp. of text and advertisements.

This little book is intended to be a help to Army people entering upon a tour of duty in the Philippines.

It contains much useful information and valuable suggestions, even for those who have previously served in the islands. It has many carefully selected advertisements; but it is not in itself an advertisement, and would undoubtedly be found of value by anyone starting for Manila.

It is for free distribution. Copies will be found on all transports en route to the Philippines. Any person who wishes it may get a copy by writing to Mrs. Roger S. Fitch, care Capt. R. S. Fitch, A.D.C., Headquarters Central Department, U. S. Army, Chicago, Ill.

◆ ◆ ◆

Examplesin Alternating Currents. (For Students and Engineers.) Vol. I, 2nd Edition with additions. By Prof. F. E. Austin, Box 441, Hanover, N. H. 5" x 7½". 223 pp. 4 plates, 70 figures. 1916. Price: flexible leather, $2.40; cloth $2.00.

The first edition of this book was reviewed in the Nov.-Dec., 1915, number of the JOURNAL OF THE UNITED STATES ARTILLERY. The 2nd edition is not materially altered from the first.

The book has proven its value in actual use. In so far as the writer of the review is aware, it is the most complete set of illustrative examples in alternating currents that has appeared in print.

The plates and numerous diagrams add greatly to the value of the book. The explanation of the notation and of the formulas used in alternating current work is clear and complete.

There is a type solution, followed by illustrative examples, for practically every condition that could arise in alternating current work.

It is believed that a table of chapter headings and chapter contents could be added with advantage to the first of the book. This would enable the user of the book to readily refer to any particular type of problem for which he mightbe seeking.

The use of green ink has been objected to by users of the book and it is not clear why the author chose to present the book in this unusual color.

It is believed that those engaged in instruction work involving alternating currents will find the book especially valuable and will be grateful to the author for this contribution to the literature on the subject.

◆ ◆ ◆

Small Problems for Infantry. By Captain A. W. Bjornstad, 16th Infantry. Fort Leavenworth, Kansas: The Army Service Schools. 6" x 9". 191 pp. 1 il. 1 map. 1916. $0.75 postpaid.

This book while written primarily for non-commissioned officers of infantry, should be of great value, not only to them, but to young officers and non-commissioned officers of every branch of the service.

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